THE POSITIVE PHILOSOPHY
OF
AUGUSTE COMTE

TRANSLATED by HARRIET MARTINEAU

MADISON, WIS.
No. 682

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OF

AUGUSTE COMTE.

TRANSLATED

BY

HARRIET MARTINEAU

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PREFACE

It may appear strange that, in these days, when the French language is almost as familiar to English readers as their own, I should have spent many months in rendering into English a work which presents no difficulties of language, and which is undoubtedly known to all philosophical students. Seldom as Comte's name is mentioned in England, there is no doubt in the minds of students of his great work that most or all of those who have added substantially to our knowledge for many years past are fully acquainted with it, and are under obligations to it which they would have thankfully acknowledged, but for the fear of offending the prejudices of the society in which they live. Whichever way we look over the whole field of science, we see the truths and ideas presented by Comte cropping out from the surface, and tacitly recognised as the foundation of all that is systematic in our knowledge. This being the case, it may appear to be a needless labor to render into our own tongue what is clearly existing in so many of the minds which are guiding and forming popular views. But it was not without reason that I undertook so serious a labor, while so much work was waiting to be done which might seem to be more urgent.

One reason, though not the chief, was that it seems to me unfair, through fear or indolence, to use the benefits conferred on us by M. Comte without acknowledgment. His fame is no doubt safe. Such a work as this is sure of receiving due honor, sooner or later. Before the end of the century, society at large will have become aware that this work is one of the chief honors of the century, and that its authors name will rank with those of the worthies who have illustrated former ages: but it does not seem to me right to

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assist in delaying the recognition till the author of so noble a service is beyond the reach of our gratitude and honor: and that it is demoralizing to ourselves to accept and use such a boon as he has given us in a silence which is in fact ingratitude. His honors we can not share: they are his own and incommunicable. His trials we may share, and, by sharing, lighten; and he has the strongest claim upon us for sympathy and fellowship in any popular disrepute which, in this case, as in all cases of signal social service, attends upon a first movement. Such sympathy and fellowship will, I trust, be awakened and extended in proportion to the spread among us of a popular knowledge of what M. Comte has done: and this hope was one reason, though, as I have said, not the chief, for my undertaking to reproduce his work in England in a form as popular as its nature admits.

A stronger reason was that M. Comte's work, in its original form, does no justice to its importance, even in France; and much less in England. It is in the form of lectures, the delivery of which was spread over a long course of years; and this extension of time necessitated an amount of recapitulation very injurious to its interest and philosophical aspect. M. Comte's style is singular. It is at the same time rich and diffuse. Every sentence is full fraught with meaning; yet it is overloaded with words. His scrupulous honesty leads him to guard his enunciations with epithets so constantly repeated, that though, to his own mind, they are necessary in each individual instance, they become wearisome, especially toward the end of his work, and lose their effect by constant repetition. This practice, which might be strength in a series of instructions spread over twenty years, becomes weakness when those instructions are presented as a whole; and it appeared to me worth while to condense his work, if I undertook nothing more, in order to divest it of the disadvantages arising from redundancy alone. My belief is that thus, if nothing more were done, it might be brought before the minds of many who would be deterred from the study of it by its bulk. What I have given in this volume occupies in the original six volumes averaging nearly eight hundred pages: and yet I believe it will be found that nothing essential to either statement or illustration is omitted.

My strongest inducement to this enterprise was my deep conviction of our need of this book in my own country, in a form which renders it accessible to the largest number of intelligent readers. We are living in a remarkable time, when the conflict of opinions renders a firm foundation of knowledge indispensable, not only to our intellectual, moral, and social progress, but to our holding such ground as we have gained from former ages. While our science is split up into arbitrary divisions; while abstract and concrete science are confounded together, and even mixed up with their application to the arts, and with natural history; and while the researches of the scientific world are presented as mere accretions to a heterogeneous mass of facts, there can be no hope of a scientific progress which shall satisfy and benefit those large classes of students whose business it is, not to explore, but to receive. The growth of a scientific taste among the working classes of this country is one of the most striking of the signs of the times. I believe no one can inquire into the mode of life of young men of the middle and operative classes without being struck with the desire that is shown, and the sacrifices that are made, to obtain the means of scientific study. That such a disposition should be baffled, and such study rendered almost ineffectual, by the desultory character of scientific exposition in England, while such a work as Comte's was in existence, was not to be borne, if a year or two of humble toil could help, more or less, to supply the need.

In close connection with this was another of my reasons. The supreme dread of every one who cares for the good of nation or race is that men should be adrift for want of an anchorage for their convictions. I believe that no one questions that a very large proportion of our people are now so adrift. With pain and fear, we see that a multitude, who might and should be among the wisest and best of our citizens, are alienated for ever from the kind of faith which sufficed for all in an organic period which has passed away, while no one has presented to them, and they can not obtain for themselves, any ground of conviction as firm and clear as that which sufficed for our fathers in their day. The moral dangers of such a state of fluctuation as has thus arisen are fearful in the extreme, whether the transition stage from one order of convictions to another be long or short. The work of M. Comte is unquestionably the greatest single effort that has been made to obviate this kind of danger; and my deep persuasion is that it will be found to retrieve a vast amount of wandering, of unsound speculation, of listless or reckless doubt, and of moral uncertainty and depression. Whatever else may be thought of the work, it will not be denied that it ascertains with singular sagacity and soundness the foundations of human knowledge, and its true object and scope;

and that it establishes the true filiation of the sciences within the boundaries of its own principle. Some may wish to interpolate this or that; some to amplify, and perhaps, here and there, in the most obscure recesses of the great edifice, to transpose, more or less: but any who question the general soundness of the exposition, or of the relations of its parts, are of another school, and will simply neglect the book, and occupy themselves as if it had never existed. It is not for such that I have been working, but for students who are not schoolmen; who need conviction, and must best know when their need is satisfied. When this exposition of Positive Philosophy unfolds itself in order before their eyes, they will, I am persuaded, find there at least a resting-place for their thought—a rallying-point of their scattered speculations—and possibly an immoveable basis for their intellectual and moral convictions. The time will come when the book itself will, for a while, be most discussed on account of the deficiencies which M. Comte himself presses on our notice; and when his philosophy will sustain amplifications of which he himself does not dream. It must be so, in the inevitable growth of knowledge and evolution of philosophy; and it is the fate which the philosopher himself should covet, because it is only a true book that could survive to be so treated: but, in the meantime, it gives us the basis that we demand, and the principle of action that we want, and as much instruction in the procedure, and information as to what has been already achieved, as could be given in our time; perhaps more than could have been given by any other mind of our time. Even Mathematics is here first constituted a science, venerable and unquestionable as mathematical truths have been for ages past: and we are led on, tracing as we go the clear genealogy of the sciences, till we find ourselves among the elements of Social science, as yet too crude and confused to be established, like the others, by a review of what had before been achieved; but now, by the hand of our master, discriminated, arranged, and consolidated, so as to be ready to fulfil the conditions of true science as future generations bring their contributions of knowledge and experience to build upon the foundation here laid. A thorough familiarity with the work in which all this is done would avail more to extinguish the anarchy of popular and sectional opinion in this country than any other influence that has yet been exerted, or, I believe, proposed.

It was under such convictions as these that I began, in the spring of 1851, the analysis of this work, in preparation for a translation.

A few months afterward, an unexpected aid presented itself. My purpose was related to the late Mr. Lombe, who was then residing at Florence. He was a perfect stranger to me. He told me, in a subsequent letter, that he had wished, for many years, to do what I was then attempting, and had been prevented only by ill health. My estimate of M. Comte's work, and my expectations from its introduction into England in the form of a condensed translation, were fully shared by him; and, to my utter amazement, he sent me, as the first act of our correspondence, an order on his bankers for five hundred pounds sterling. There was time, before his lamented death, for me to communicate to him my views as to the disposal of this money, and to obtain the assurance of his approbation. We planned that the larger proportion of it should be expended in getting out the work, and promoting its circulation. The last words of his last letter were an entreaty that I would let him know if more money would, in any way, improve the quality of my version, or aid the promulgation of the book. It was a matter of deep concern to me that he died before I could obtain his opinion as to the manner in which I was doing my work. All that remained was to carry out his wishes as far as possible; and to do this, no pains have been spared by myself, or by Mr. Chapman, who gave him the information that called forth his bounty.

As to the method I have pursued with my work—there will be different opinions about it, of course. Some will wish that there had been no omissions, while others would have complained of length and heaviness, if I had offered a complete translation. Some will ask why it is not a close version as far as it goes; and others, I have reason to believe, would have preferred a brief account, out of my own mind, of what Comte's philosophy is, accompanied by illustrations of my own devising. A wider expectation seems to be that I should record my own dissent, and that of some critics of much more weight, from certain of M. Comte's views. I thought long and anxiously of this; and I was not insensible to the temptation of entering my protest, here and there, against a statement, a conclusion, or a method of treatment. I should have been better satisfied still to have adduced some critical opinions of much higher value than any of mine can be. But my deliberate conclusion was that this was not the place nor the occasion for any such controversy. What I engaged to do was to present M. Comte's first great work in a useful form for English study; and it appears to me that it would be presumptuous to thrust in my own criticisms.

and out of place to insert those of others. Those others can speak for themselves, and the readers of the book can criticise it for themselves. No doubt, they may be trusted not to mistake my silence for assent, nor to charge me with neglect of such criticism as the work has already evoked in this country. While I have omitted some pages of the Author's comments on French affairs, I have not attempted to alter his French view of European politics. In short, I have endeavored to bring M. Comte and his English readers face to face, with as little drawback as possible from intervention.

This by no means implies that the translation is a close one. It is a very free translation. It is more a condensation than an abridgment: but it is an abridgment too. My object was to convey the meaning of the original in the clearest way I could; and to this all other considerations were made to yield. The serious view that I have taken of my enterprise is proved by the amount of labor and of pecuniary sacrifice that I have devoted to my task. Where I have erred, it is from want of ability; for I have taken all the pains I could.

One suggestion that I made to Mr. Lombe, and that he approved, was that the three sections—Mathematics, Astronomy, and Physics—should be revised by a qualified man of science. My personal friend Professor Nichol, of Glasgow, was kind enough to undertake this service. After two careful readings, he suggested nothing material in the way of alteration, in the case of the first two sections, except the omission of Comte's speculation on the possible mathematical verification of Laplace's Cosmogony. But more had to be done with regard to the treatment of Physics: Every reader will see that that section is the weakest part of the book, in regard both to the organization and the details of the subject. In regard to the first, the author explains the fact, from the nature of the case, that Physics is rather a repository of somewhat fragmentary portions of physical science, the correlation of which is not yet clear, than a single circumscribed science. And we must say for him, in regard to the other kind of imperfection, that such advances have been made in almost every department of Physics since his second volume was published, that it would be unfair to present what he wrote under that head in 1835 as what he would have to say now. The choice lay therefore between almost rewriting this portion of M. Comte's work, or so largely abridging it that only a skeleton presentment of general principles should remain. But as the system of Positive Philosophy is much less an Expository than a Critical work, the latter alternative alone seemed open, under due consideration of justice to the Author. I have adopted therefore the plan of extensive omissions, and have retained the few short memoranda in which Professor Nichol suggested these, as notes. Although this gentleman has sanctioned my presentment of Comte's chapters on Mathematics and Physics, it must not be inferred that he agrees with his Method in Mental Philosophy, or assents to other conclusions held of main importance by the disciples of the Positive Philosophy.' The contrary, indeed, is so apparent in the tenor of his own writings, that so far as his numerous readers are concerned, this remark need not have been offered. With the reservation I have made, I am bound to take the entire responsibility—the Work being absolutely and wholly my own.

It will be observed that M. Comte's later works are not referred to in any part of this book. It appears to me that they, like our English criticisms on the present Work, had better be treated of separately. Here his analytical genius has full scope; and what there is of synthesis is, in regard to social science, merely what is necessary to render his analysis possible and available. For various reasons, I think it best to stop here, feeling assured that if this Work fulfils its function, all else with which M. Comte has thought fit to follow it up will be obtained as it is demanded.

During the whole course of my long task, it has appeared to me that Comte's work is the strongest embodied rebuke ever given to that form of theological intolerance which censures Positive Philosophy for pride of reason and lowness of morals. The imputation will not be dropped, and the enmity of the religious world to the book will not slacken for its appearing among us in an English version. It can not be otherwise. The theological world can not but hate a book which treats of theological belief as a transient state of the human mind. And again, the preachers and teachers, of all sects and schools, who keep to the ancient practice, once inevitable, of contemplating and judging of the universe from the point of view of their own minds, instead of having learned to take their stand out of themselves, investigating from the universe inward, and not from within outward, must necessarily think ill of a work which exposes the futility of their method, and the worthlessness of the results to which it leads. As M. Comte treats of theology and metaphysics as destined to pass away, theologians and metaphysicians must necessarily abhor, dread, and despise his work. They merely express their own natural feelings on behalf of the objects of their reverence and the purpose of their lives, when they charge Positive Philosophy with irreverence, lack of aspiration, hardness, deficiency of grace and beauty, and so on. They are no judges of the case. Those who are — those who have passed through theology and metaphysics, and, finding what they are now worth, have risen above them — will pronounce a very different judgment on the contents of this book, though no appeal for such a judgment is made in it, and this kind of discussion is nowhere expressly provided for. To those who have learned the difficult task of postponing dreams to realities till the beauty of reality is seen in its full disclosure, while that of dreams melts into darkness, the moral charm of this work will be as impressive as its intellectual satisfactions. The aspect in which it presents Man is as favorable to his moral discipline, as it is fresh and stimulating to his intellectual taste. We find ourselves suddenly living and moving in the midst of the universe,— as a part of it, and not as its aim and object. We find ourselves living, not under capricious and arbitrary conditions, unconnected with the constitution and movements of the whole, but under great, general, invariable laws, which operate on us as a part of the whole. Certainly, I can conceive of no instruction so favorable to aspiration as that which shows us how great are our faculties, how small our knowledge, how sublime the heights which we may hope to attain, and how boundless an infinity may be assumed to spread out beyond. We find here indications in passing of the evils we suffer from our low aims, our selfish passions, and our proud ignorance; and in contrast with them, animating displays of the beauty and glory of the everlasting laws, and of the sweet serenity, lofty courage, and noble resignation, that are the natural consequence of pursuits so pure, and aims so true, as those of Positive Philosophy. Pride of intellect surely abides with those who insist on belief without evidence and on a philosophy derived from their own intellectual action, without material and corroboration from without, and not with those who are too scrupulous and too humble to transcend evidence, and to add, out of their own imaginations, to that which is, and may be, referred to other judgments. If it be desired to extinguish presumption, to draw away from low aims, to fill life with worthy occupations and elevating pleasures, and to raise human hope and human effort to the highest attainable point, it seems to me that the best resource is the pursuit of Positive Philosophy, with its train of noble truths and irresistible inducements. The prospects it opens are boundless; for among the laws it establishes that of human progress is conspicuous. The virtues it fosters are all those of which Man is capable; and the noblest are those which are more eminently fostered. The habit of truth-seeking and truth-speaking, and of true dealing with self and with all things, is evidently a primary requisite; and this habit once perfected, the natural conscience, thus disciplined, will train up all other moral attributes to some equality with it. To all who know what the study of philosophy really is—which means the study of Positive Philosophy—its effect on human aspiration and human discipline is so plain that any doubt can be explained only on the supposition that accusers do not know what it is that they are calling in question. My hope is that this book may achieve, besides the purposes entertained by its author, the one more that he did not intend, of conveying a sufficient rebuke to those who, in theological selfishness or metaphysical pride, speak evil of a philosophy which is too lofty and too simple, too humble and too generous, for the habit of their minds. The case is clear. The law of progress is conspicuously at work throughout human history. The only field of progress is now that of Positive Philosophy, under whatever name it may be known to the real students of every sect; and therefore must that philosophy be favorable to those virtues whose repression would be incompatible with progress.

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POSITIVE PHILOSOPHY.

INTRODUCTION.

CHAPTER I.

ACCOUNT OF THE AIM OF THIS WORK.—VIEW OF THE NATURE AND IMPORTANCE OF THE POSITIVE PHILOSOPHY.

A GENERAL statement of any system of philosophy may be either a sketch of a doctrine to be established, or a summary of a doctrine already established. If greater value belongs to the last, the first is still important, as characterizing from its origin the subject to be treated. In a case like the present, where the proposed study is vast and hitherto indeterminate, it is especially important that the field of research should be marked out with all possible accuracy. For this purpose, I will glance at the considerations which have originated this work, and which will be fully elaborated in the course of it.

In order to understand the true value and character of the Positive Philosophy, we must take a brief general view of the progressive course of the human mind, regarded as a whole; for no conception can be understood otherwise than through its history.

Law of human progress.

From the study of the development of human intelligence, in all directions, and through all times, the discovery arises of a great fundamental law, to which it is necessarily subject, and which has a solid foundation of proof, both in the facts of our organization and in our historical experience. The law is this:—that each of our leading conceptions—each branch of our knowledge—passes successively through three different theoretical condititions: the Theological, or fictitious; the Metaphysical, or abstract; and the Scientific, or positive. In other words, the human mind, by its nature, employs in its progress three methods of philosophizing, the character of which is essentially different, and even radically opposed: viz., the theological method, the metaphysical, and the positive. Hence arise three philosophies, or general systems of conceptions on the aggregate of phenomena, each of which excludes the others. The first is the necessary point of departure of the human understanding; and the third is its fixed and definite state. The second is merely a state of transition.

First Stage.

In the theological state, the human mind, seeking the essential nature of beings, the first and final causes (the origin and purpose) of all effects—in short, Absolute knowledge—supposes all phenomena to be produced by the immediate action of supernatural beings.

Second Stage.

In the metaphysical state, which is only a modification of the first, the mind supposes, instead of supernatural beings, abstract forces, veritable entities (that is, personified abstractions) inherent in all beings, and capable of producing all phenomena. What is called the explanation of phenomena is, in this stage, a mere reference of each to its proper entity.

Third Stage.

In the final, the positive state, the mind has given over the vain search after Absolute notions, the origin and destination of the universe, and the causes of phenomena, and applies itself to the study of their laws—that is, their invariable relations of succession and resemblance. Reasoning and observation, duly combined, are the means of this knowledge. What is now understood when we speak of an explanation of facts is simply the establishment of a connection between single phenomena and some general facts, the number of which continually diminishes with the progress of science.

Ultimate point of each.

The Theological system arrived at the highest perfection of which it is capable when it substituted the providential action of a single Being for the varied operations of the numerous divinities which had been before imagined. In the same way, in the last stage of the Metaphysical system, men substitute one great entity (Nature) as the cause of all phenomena, instead of the multitude of entities at first supposed. In the same way, again, the ultimate perfection of the Positive system would be (if such perfection could be hoped for) to represent all phenomena as particular aspects of a single general fact—such as Gravitation, for instance.

The importance of the working of this general law will be established hereafter. At present, it must suffice to point out some of the grounds of it.

Evidences of the law.

There is no science which, having attained the positive stage, does not bear marks of having passed through the others. Some time since it was (whatever it might be) composed, as we can now perceive, of metaphysical abstractions; and, further back in the course of time, it took its form from theological conceptions. Actual. We shall have only too much occasion to see, as we proceed, that our most advanced sciences still bear very evident marks of the two earlier periods through which they have passed.

The progress of the individual mind is not only an illustration, but an indirect evidence of that of the general mind. The point of departure of the individual and of the race being the same, the phases of the mind of a man correspond to the epochs of the mind of the race. Now, each of us is aware, if he looks back upon his own history, that he was a theologian in his childhood, a metaphysician in his youth, and a natural philosopher in his manhood. All men who are up to their age can verify this for themselves.

Besides the observation of facts, we have theoretical reasons in support of this law.

Theoretical.

The most important of these reasons arises from the necessity that always exists for some theory to which to refer our facts, combined with the clear impossibility that, at the outset of human knowledge, men could have formed theories out of the observation of facts. All good intellects have repeated, since Bacon's time, that there can be no real knowledge but that which is based on observed facts. This is incontestable, in our present advanced stage; but, if we look back to the primitive stage of human knowledge, we shall see that it must have been otherwise then. If it is true that every theory must be based upon observed facts, it is equally true that facts can not be observed without the guidance of some theory. Without such guidance, our facts would be desultory and fruitless; we could not retain them: for the most part we could not even perceive them.

Thus, between the necessity of observing facts in order to form a theory, and having a theory in order to observe facts, the human mind would have been entangled in a vicious circle, but for the natural opening afforded by Theological conceptions. This is the fundamental reason for the theological character of the primitive philosophy. This necessity is confirmed by the perfect suitability of the theological philosophy to the earliest researches of the human mind. It is remarkable that the most inaccessible questions —those of the nature of beings, and the origin and purpose of phenomena—should be the first to occur in a primitive state, while those which are really within our reach are regarded as almost unworthy of serious study. The reason is evident enough:—that experience alone can teach us the measure of our powers; and if men had not begun by an exaggerated estimate of what they can do, they would never have done all that they are capable of. Our organization requires this. At such a period there could have been no reception of a positive philosophy, whose function is to discover the laws of phenomena, and whose leading characteristic it is to regard as interdicted to human reason those sublime mysteries which theology explains, even to their minutest details, with the most attractive facility. It is just so under a practical view of the nature of the researches with which men first occupied themselves. Such inquiries offered the powerful charm of unlimited empire over the external world—a world destined wholly for our use, and involved in every way with our existence. The theological philosophy, presenting this view, administered exactly the stimulus necessary to incite the human mind to the irksome labor without which it could make no progress. We can now scarcely conceive of such a state of things, our reason having become sufficiently mature to enter upon laborious scientific researches, without needing any such stimulus as wrought upon the imaginations of astrologers and alchemists. We have motive enough in the hope of discovering the laws of phenomena, with a view to the confirmation or rejection of a theory. But it could not be so in the earliest days; and it is to the chimeras of astrology and alchemy that we owe the long series of observations and experiments on which our positive science is based. Kepler felt this on behalf of astronomy, and Berthollet on behalf of chemistry. Thus was a spontaneous philosophy, the theological, the only possible beginning, method, and provisional system, out of which the Positive philosophy could grow. It is easy, after this, to perceive how Metaphysical methods and doctrines must have afforded the means of transition from the one to the other.

The human understanding, slow in its advance, could not step at once from the theological into the positive philosophy. The two are so radically opposed, that an intermediate system of conceptions has been necessary to render the transition possible. It is only in doing this, that metaphysical conceptions have any utility whatever. In contemplating phenomena, men substitute for supernatural direction a corresponding entity. This entity may have been supposed to be derived from the supernatural action: but it is more easily lost sight of, leaving attention free from the facts themselves, till, at length, metaphysical agents have ceased to be anything more than the abstract names of phenomena. It is not easy to say by what other process than this our minds could have passed from supernatural considerations to natural; from the theological system to the positive.

The law of human development being thus established, let us consider what is the proper nature of the Positive Philosophy.

Character of the Positive Philosophy.

As we have seen, the first characteristic of the Positive Philosophy is that it regards all phenomena as subjected to invariable natural *Laws*. Our business is,—seeing how vain is any research into what are called *Causes*, whether first or final,—to pursue an accurate discovery of these Laws, with a view to reducing them to the smallest possible number. By speculating upon causes, we could solve no difficulty about origin and purpose. Our real business is to analyse accurately the circumstances of phenomena, and to connect them by the natural relations of succession and resemblance. The best illustration of this is in the case of the doctrine of Gravitation. We say that the general phenomena of the universe are *explained* by it, because it connects under one head the whole immense variety of astronomical facts; exhibiting the constant tendency of atoms toward each other in direct proportion to their masses, and in inverse proportion to the squares of their distance; while the general fact itself is a mere extension of one which is perfectly familiar to us, and which we therefore say that we know;—the weight of bodies on the surface of the earth. As to what weight and attraction are, we have nothing to do with that, for it is not a matter of knowledge at all. Theologians and metaphysicians may imagine and refine about such questions; but positive philosophy rejects them. When any attempt has been made to explain them, it has ended only in saying that attraction is universal weight, and that weight is terrestrial attraction: that is, that the two orders of phenomena are identical; which is the point from which the question set out. Again, M. Fourier, in his fine series of researches on Heat, has given us all the most important and precise laws of the phenomena of heat, and many large and new truths, without once inquiring into its nature, as his predecessors had done when they disputed about calorific matter and the action of a universal ether. In treating his subject in the Positive method, he finds inexhaustible material for all his activity of research, without betaking himself to insoluble questions.

History of the Positive Philosophy.

Before ascertaining the stage which the Positive Philosophy has reached, we must bear in mind that the different kinds of our knowledge have passed through the three stages of progress at different rates, and have not therefore arrived at the same time. The rate of advance depends on the nature of the knowledge in question, so distinctly that, as we shall see hereafter, this consideration constitutes an accessary to the fundamental law of progress. Any kind of knowledge reaches the positive stage early in proportion to its generality, simplicity, and independence of other departments. Astronomical science, which is above all made up of facts that are general, simple, and independent of other sciences, arrived first; then terrestrial Physics; then Chemistry; and, at length, Physiology.

It is difficult to assign any precise date to this revolution in science. It may be said, like everything else, to have been always going on; and especially since the labors of Aristotle and the school of Alexandria; and then from the introduction of natural science into the West of Europe by the Arabs. But, if we must fix upon some marked period, to serve as a rallying point, it must be that,—about two centuries ago,—when the human mind was astir under the precepts of Bacon, the conceptions of Descartes, and the discoveries of Galileo. Then it was that the spirit of the Positive philosophy rose up in opposition to that of the superstitious and scholastic systems which had hitherto obscured the true character of all science. Since that date, the progress of the Positive philosophy, and the decline of the other two, have been so marked that no rational mind now doubts that the revolution is destined to go on to its completion,—every branch of knowledge being, sooner or later, brought within the operation of Positive philosophy. This is not yet the case. Some are still lying outside: and not till they are brought in will the Positive philosophy possess that character of universality which is necessary to its definitive constitution.

New department of Positive philosophy.

In mentioning just now the four principal categories of phenomena,—astronomical, physical, chemical, and physiological,—there was an omission which will have been noticed. Nothing was said of Social phenomena. Though involved with the physiological, Social phenomena demand a distinct classification, both on account of their importance and of their difficulty. They are the most individual, the most complicated, the most dependent on all others; and therefore they must be the latest,—even if they had no special obstacle to encounter. This branch of science has not hitherto entered into the domain of Positive philosophy. Theological and metaphysical methods, exploded in other departments, are as yet exclusively applied, both in the way of inquiry and discussion, in all treatment of Social subjects, though the best minds are heartily weary of eternal disputes about divine right and the sovereignty of the people. This is the great, while it is evidently the only gap which has to be filled, to constitute, solid and entire, the Positive Philosophy. Now that the human mind has grasped celestial and terrestrial physics,—mechanical and chemical; organic physics, both vegetable and animal,—there remains one science, to fill up the series of sciences of observation,—Social physics. This is what men have now most need of: and this it is the principal aim of the present work to establish.

Social Physics.

It would be absurd to pretend to offer this new science at once in a complete state. Others, less new, are in very unequal conditions of forwardness. But the same character of positivity which is impressed on all the others will be shown to belong to this. This once done, the philosophical system of the moderns will be in fact complete, as there will then be no phenomenon which does not naturally enter into some one of the five great categories. All our fundamental conceptions having become homogeneous, the Positive state will be fully established. It can never again change its character, though it will be for ever in course of development by additions of new knowledge. Having acquired the character of universality which has hitherto been the only advantage resting with the two preceding systems, it will supersede them by its natural superiority, and leave to them only an historical existence.

Secondary aim of this work.

We have stated the special aim of this work. Its secondary and general aim is this:—to review what has been effected in the Sciences, in order to show that they are not radically separate, but all branches from the same trunk. If we had confined ourselves to the first and special object of the work, we should have produced merely a study of Social physics: whereas, in introducing the second and general, we offer a study of Positive philosophy, passing in review all the positive sciences already formed.

To review the philosophy of the Sciences.

The purpose of this work is not to give an account of the Natural Sciences. Besides that it would be endless, and that it would require a scientific preparation such as no one man possesses, it would be apart from our object, which is to go through a course of not Positive Science, but Positive Philosophy. We have only to consider each fundamental science in its relation to the whole positive system, and to the spirit which characterizes it; that is, with regard to its methods and its chief results.

The two aims, though distinct, are inseparable; for, on the one hand, there can be no positive philosophy without a basis of social science, without which it could not be all-comprehensive; and, on the other hand, we could not pursue Social science without having been prepared by the study of phenomena less complicated than those of society, and furnished with a knowledge of laws and anterior facts which have a bearing upon social science. Though the fundamental sciences are not all equally interesting to ordinary minds, there is no one of them that can be neglected in an inquiry like the present; and, in the eye of philosophy, all are of equal value to human welfare. Even those which appear the least interesting have their own value, either on account of the perfection of their methods, or as being the necessary basis of all the others.

Speciality.

Lest it should be supposed that our course will lead us into a wilderness of such special studies as are at present the bane of a true positive philosophy, we will briefly advert to the existing prevalence of such special pursuit. In the primitive state of human knowledge there is no regular division of intellectual labor. Every student cultivates all the sciences. As knowledge accrues, the sciences part off; and students devote themselves each to some one branch. It is owing to this division of employment, and concentration of whole minds upon a single department, that science has made so prodigious an advance in modern times; and the perfection of this division is one of the most important characteristics of the Positive philosophy. But, while admitting all the merits of this change, we can not be blind to the eminent disadvantages which arise from the limitation of minds to a particular study. It is inevitable that each should be possessed with exclusive notions, and be therefore incapable of the general superiority of ancient students, who actually owed that general superiority to the inferiority of their knowledge. We must consider whether the evil can be avoided without losing the good of the modern arrangement; for the evil is becoming urgent. We all acknowledge that the divisions established for the convenience of scientific pursuit are radically artificial; and yet there are very few who can embrace in idea the whole of any one science: each science moreover being itself only a part of a great whole. Almost every one is busy about his own particular section, without much thought about its relation to the general system of positive knowledge. We must not be blind to the evil, nor slow

Proposed new class of students.

in seeking a remedy. We must not forget that this is the weak side of the positive philosophy, by which it may yet be attacked, with some hope of success, by the adherents of the theological and metaphysical systems. As to the remedy, it certainly does not lie in a return to the ancient confusion of pursuits, which would be mere retrogression, if it were possible, which it is not. It lies in perfecting the division of employments itself,—in carrying it one degree higher,—in constituting one more speciality from the study of scientific generalities. Let us have a new class of students, suitably prepared, whose business it shall be to take the respective sciences as they are, determine the spirit of each, ascertain their relations and mutual connection, and reduce their respective principles to the smallest number of general principles, in conformity with the fundamental rules of the Positive Method. At the same time, let other students be prepared for their special pursuit by an education which recognises the whole scope of positive science, so as to profit by the labors of the students of generalities, and so as to correct reciprocally, under that guidance, the results obtained by each. We see some approach already to this arrangement. Once established, there would be nothing to apprehend from any extent of division of employments. When we once have a class of learned men, at the disposal of all others, whose business it shall be to connect each new discovery with the general system, we may dismiss all fear of the great whole being lost sight of in the pursuit of the details of knowledge. The organization of scientific research will then be complete; and it will henceforth have occasion only to extend its development, and not to change its character. After all, the formation of such a new class as is proposed would be merely an extension of the principle which has created all the classes we have. While science was narrow, there was only one class: as it expanded, more were instituted. With a further advance a fresh need arises, and this new class will be the result.

Advantages of the Positive Philosophy.

The general spirit of a course of Positive Philosophy having been thus set forth, we must now glance at the chief advantages which may be derived, on behalf of human progression, from the study of it. Of these advantages, four may be especially pointed out.

Illustrates the Intellectual function.

I. The study of the Positive Philosophy affords the only rational means of exhibiting the logical laws of the human mind, which have hitherto been sought by unfit methods. To explain what is meant by this, we may refer to a saying of M. de Blainville, in his work on Comparative Anatomy, that every active, and especially every living being, may be regarded under two relations—the Statical and the Dynamical; that is, under conditions or in action. It is clear that all considerations range themselves under the one or the other of these heads. Let us apply this classification to the intellectual functions.

If we regard these functions under their Statical aspect—that is, if we consider the conditions under which they exist—we must determine the organic circumstances of the case, which inquiry involves it with anatomy and physiology. If we look at the Dynamic aspect, we have to study simply the exercise and results of the intellectual powers of the human race, which is neither more nor less than the general object of the Positive Philosophy. In short, looking at all scientific theories as so many great logical facts, it is only by the thorough observation of these facts that we can arrive at the knowledge of logical laws. These being the only means of knowledge of intellectual phenomena, the illusory psychology, which is the last phase of theology, is excluded. It pretends to accomplish the discovery of the laws of the human mind by contemplating it in itself; that is, by separating it from causes and effects. Such an attempt, made in defiance of the physiological study of our intellectual organs, and of the observation of rational methods of procedure, can not succeed at this time of day.

The Positive Philosophy, which has been rising since the time of Bacon, has now secured such a preponderance, that the metaphysicians themselves profess to ground their pretended science on an observation of facts. They talk of external and internal facts, and say that their business is with the latter. This is much like saying that vision is explained by luminous objects painting their images upon the retina. To this the physiologists reply that another eye would be needed to see the image. In the same manner, the mind may observe all phenomena but its own. It may be said that a man's intellect may observe his passions, the seat of the reason being somewhat apart from that of the emotions in the brain; but there can be nothing like scientific observation of the passions, except from without, as the stir of the emotions disturbs the observing faculties more or less. It is yet more out of the question to make an intellectual observation of intellectual processes. The observing and observed organ are here the same, and its action can not be pure and natural. In order to observe, your intellect must pause from activity; yet it is this very activity that you want to observe. If you can not effect the pause, you can not observe: if you do effect it, there is nothing to observe. The results of such a method are in proportion to its absurdity. After two thousand years of psychological pursuit, no one proposition is established to the satisfaction of its followers. They are divided, to this day, into a multitude of schools, still disputing about the very elements, of their doctrine. This interior observation gives birth to almost as many theories as there are observers. We ask in vain for any one discovery, great or small, which has been made under this method. The psychologists have done some good in keeping up the activity of our understandings, when there was no better work for our faculties to do; and they may have added something to our stock of knowledge. If they have done so, it is by practising the Positive method—by observing the progress of the human mind in the light of science; that is, by ceasing, for the moment, to be psychologists.

The view just given in relation to logical Science becomes yet more striking when we consider the logical Art.

The Positive Method can be judged of only in action. It can not be looked at by itself, apart from the work on which it is employed. At all events, such a contemplation would be only a dead study, which could produce nothing in the mind which loses time upon it. We may talk for ever about the method, and state it in terms very wisely, without knowing half so much about it as the man who has once put it in practice upon a single particular of actual research, even without any philosophical intention. Thus it is that psychologists, by dint of reading the precepts of Bacon and the discourses of Descartes, have mistaken their own dreams for science.

Without saying whether it will ever be possible to establish, *à priori*, a true method of investigation, independent of a philosophical study of the sciences, it is clear that the thing has never been done yet, and that we are not capable of doing it now. We can not, as yet, explain the great logical procedures, apart from their applications. If we ever do, it will remain as necessary then as now to form good intellectual habits by studying the regular application of the scientific methods which we shall have attained.

This, then, is the first great result of the Positive Philosophy—the manifestation by experiment of the laws which rule the Intellect in the investigation of truth; and, as a consequence, the knowledge of the general rules suitable for that object.

Must regenerate Education.

II. The second effect of the Positive Philosophy, an effect not less important and far more urgently wanted, will be to regenerate Education.

The best minds are agreed that our European education, still essentially theological, metaphysical, and literary, must be superseded by a Positive training, conformable to our time and needs. Even the governments of our day have shared, where they have not originated, the attempts to establish positive instruction; and this is a striking indication of the prevalent sense of what is wanted. While encouraging such endeavors to the utmost, we must not however, conceal from ourselves that everything yet done is inadequate to the object. The present exclusive specialty of our pursuits, and the consequent isolation of the sciences, spoil our teaching. If any student desires to form an idea of natural philosophy as a whole, he is compelled to go through each department as it is now taught, as if he were to be only an astronomer, or only a chemist; so that, be his intellect what it may, his training must remain very imperfect. And yet his object requires that he should obtain general positive conceptions of all the classes of natural phenomena. It is such an aggregate of conceptions, whether on a great or on a small scale, which must henceforth be the permanent basis of all human combinations. It will constitute the mind of future generations. In order to this regeneration of our intellectual system, it is necessary that the sciences, considered as branches from one trunk, should yield us, as a whole, their chief methods and their most important results. The specialities of science can be pursued by those whose vocation lies in that direction. They are indispensable; and they are not likely to be neglected; but they can never of themselves renovate our system of Education; and, to be of their full use, they must rest upon the basis of that general instruction which is a direct result of the Positive Philosophy.

Advances sciences by combining them.

III. The same special study of scientific generalities must also aid the progress of the respective positive sciences: and this constitutes our third head of advantages.

The divisions which we establish between the sciences are, though not arbitrary, essentially artificial. The subject of our researches is one: we divide it for our convenience, in order to deal the more easily with its difficulties. But it sometimes happens—and especially with the most important doctrines of each science—that we need what we can not obtain under the present isolation of the sciences—a combination of several special points of view; and for want of this, very important problems wait for their solution much longer than they otherwise need do. To go back into the past for example: Descartes' grand conception with regard to analytical geometry is a discovery which has changed the whole aspect of mathematical science, and yielded the germ of all future progress; and it issued from the union of two sciences which had always before been separately regarded and pursued. The case of pending questions is yet more impressive; as, for instance, in Chemistry, the doctrine of Definite Proportions. Without entering upon the discussion of the fundamental principle of this theory, we may say with assurance that, in order to determine it—in order to determine whether it is a law of nature that atoms should necessarily combine in fixed numbers—it will be indispensable that the chemical point of view should be united with the physiological. The failure of the theory with regard to organic bodies indicates that the cause of this immense exception must be investigated; and such an inquiry belongs as much to physiology as to chemistry. Again, it is as yet undecided whether azote is a simple or a compound body. It was concluded by almost all chemists that azote is a simple body; the illustrious Berzilius hesitated, on purely chemical considerations; but he was also influenced by the physiological observation that animals which receive no azote in their food have as much of it in their tissues as carnivorous animals. From this we see how physiology must unite with chemistry to inform us whether azote is simple or compound, and to institute a new series of researches upon the relation between the composition of living bodies and their mode of alimentation.

Such is the advantage which, in the third place, we shall owe to

Positive philosophy—the elucidation of the respective sciences by their combination. In the fourth place

Must reorganize society.

IV. The Positive Philosophy offers the only solid basis for that Social Reorganization which must succeed the critical condition in which the most civilized nations are now living.

It can not be necessary to prove to anybody who reads this work that Ideas govern the world, or throw it into chaos; in other words, that all social mechanism rests upon Opinions. The great political and moral crisis that societies are now undergoing is shown by a rigid analysis to arise out of intellectual anarchy. While stability in fundamental maxims is the first condition of genuine social order, we are suffering under an utter disagreement which may be called universal. Till a certain number of general ideas can be acknowledged as a rallying-point of social doctrine, the nations will remain in a revolutionary state, whatever palliatives may be devised; and their institutions can be only provisional. But whenever the necessary agreement on first principles can be obtained, appropriate institutions will issue from them, without shock or resistance; for the causes of disorder will have been arrested by the mere fact of the agreement. It is in this direction that those must look who desire a natural and regular, a normal state of society.

Now, the existing disorder is abundantly accounted for by the existence, all at once, of three incompatible philosophies—the theological, the metaphysical, and the positive. Any one of these might alone secure some sort of social order; but while the three co-exist, it is impossible for us to understand one another upon any essential point whatever. If this is true, we have only to ascertain which of the philosophies must, in the nature of things, prevail; and, this ascertained, every man, whatever may have been his former views, can not but concur in its triumph. The problem once recognised, can not remain long unsolved; for all considerations whatever point to the Positive Philosophy as the one destined to prevail. It alone has been advancing during a course of centuries, throughout which the others have been declining. The fact is incontestable. Some may deplore it, but none can destroy it, nor therefore neglect it but under penalty of being betrayed by illusory speculations. This general revolution of the human mind is nearly accomplished. We have only to complete the Positive Philosophy by bringing Social phenomena within its comprehension, and afterward consolidating the whole into one body of homogeneous doctrine. The marked preference which almost all minds, from the highest to the commonest, accord to positive knowledge over vague and mystical conceptions, is a pledge of what the reception of this philosophy will be when it has acquired the only quality that it now wants—a character of due generality. When it has become complete, its supremacy will take place spontaneously, and will re-establish order throughout society. There is, at present, no conflict but between the theological and the metaphysical philosophies They are contending for the task of reorganizing society; but it is a work too mighty for either of them. The positive philosophy has hitherto intervened only to examine both, and both are abundantly discredited by the process. It is time now to be doing something more effective, without wasting our forces in needless controversy. It is time to complete the vast intellectual operation begun by Bacon, Descartes, and Galileo, by constructing the system of general ideas which must henceforth prevail among the human race. This is the way to put an end to the revolutionary crisis which is tormenting the civilized nations of the world.

Leaving these four points of advantage, we must attend to one precautionary reflection.

No hope of reduction to a single law.

Because it is proposed to consolidate the whole of our acquired knowledge into one body of homogeneous doctrine, it must not be supposed that we are going to study this vast variety as proceeding from a single principle, and as subjected to a single law. There is something so chimerical in attempts at universal explanation by a single law, that it may be as well to secure this Work at once from any imputation of the kind, though its development will show how undeserved such an imputation would be. Our intellectual resources are too narrow, and the universe is too complex, to leave any hope that it will ever be within our power to carry scientific perfection to its last degree of simplicity. Moreover, it appears as if the value of such an attainment, supposing it possible, were greatly overrated. The only way, for instance, in which we could achieve the business, would be by connecting all natural phenomena with the most general law we know —which is that of gravitation, by which astronomical phenomena are already connected with a portion of terrestrial physics. Laplace has indicated that chemical phenomena may be regarded as simple atomic effects of the Newtonian attraction, modified by the form and mutual position of the atoms. But supposing this view proveable (which it can not be while we are without data about the constitution of bodies), the difficulty of its application would doubtless be found so great that we must still maintain the existing division between astronomy and chemistry, with the difference that we now regard as natural that division which we should then call artificial. Laplace himself presented his idea only as a philosophic device, incapable of exercising any useful influence over the progress of chemical science. Moreover, supposing this insuperable difficulty overcome, we should be no nearer to scientific unity, since we then should still have to connect the whole of physiological phenomena with the same law, which certainly would not be the least difficult part of the enterprise. Yet, all things considered, the hypothesis we have glanced at would be the most favorable to the desired unity.

The consideration of all phenomena as referable to a single origin is by no means necessary to the systematic formation of science, any more than to the realization of the great and happy consequences that we anticipate from the positive philosophy. The only necessary unity is that of Method, which is already in great part established. As for the doctrine, it need not be *one;* it is enough that it be *homogeneous.* It is, then, under the double aspect of unity of method and homogeneousness of doctrine that we shall consider the different classes of positive theories in this work. While pursuing the philosophical aim of all science, the lessening of the number of general laws requisite for the explanation of natural phenomena, we shall regard as presumptuous every attempt, in all future time, to reduce them rigorously to one.

Having thus endeavored to determine the spirit and influence of the Positive Philosophy, and to mark the goal of our labors, we have now to proceed to the exposition of the system; that is, to the determination of the universal, or encyclopædic order, which must regulate the different classes of natural phenomena, and consequently the corresponding positive sciences.

CHAPTER II.

VIEW OF THE HIERARCHY OF THE POSITIVE SCIENCES.

Failure of proposed classifications.

In proceeding to offer a Classification of the Sciences, we must leave on one side all others that have as yet been attempted. Such scales as those of Bacon and D'Alembert are constructed upon an arbitrary division of the faculties of the mind; whereas, our principal faculties are often engaged at the same time in any scientific pursuit. As for other classifications, they have failed, through one fault or another, to command assent: so that there are almost as many schemes as there are individuals to propose them. The failure has been so conspicuous, that the best minds feel a prejudice against this kind of enterprise, in any shape.

Now, what is the reason of this?—For one reason, the distribution of the sciences, having become a somewhat discredited task, has of late been undertaken chiefly by persons who have no sound knowledge of any science at all. A more important and less personal reason, however, is the want of homogeneousness in the different parts of the intellectual system,—some having successively become positive, while others remain theological or metaphysical. Among such incoherent materials, classification is of course impossible. Every attempt at a distribution has failed from this cause, without the distributor being able to see why:—without his discovering that a radical contrariety existed between the materials he was endeavoring to combine. The fact was clear enough, if it had but been understood, that the enterprise was premature; and that it was useless to undertake it till our principal scientific conceptions should all have become positive. The preceding chapter seems to show that this indispensable condition may now be considered fulfilled: and thus the time has arrived for laying down a sound and durable system of scientific order.

We may derive encouragement from the example set by recent botanists and zoologists, whose philosophical labors have exhibited the true principle of classification; viz., that the classification must proceed from the study of the things to be classified, and must by no means be determined by *à priori* considerations. The real affinities and natural connections presented by objects being allowed to determine their order, the classification itself becomes the expression of the most general fact. And thus does the positive method apply to the question of classification itself, as well as to the objects included under it. It follows that the mutual dependence of the sciences,—a dependence resulting from that of the corresponding phenomena,—must determine the arrangement of the system of human knowledge. Before proceeding to investigate this mutual dependence, we have only to ascertain the real bounds of the classification proposed: in other words, to settle what we mean by human knowledge, as the subject of this work.

True principle of classification.

Boundaries of our field.

The field of human labor is either speculation or action: and thus, we are accustomed to divide our knowledge into the theoretical and the practical. It is obvious that, in this inquiry, we have to do only with the theoretical. We are not going to treat of all human notions whatever, but of those fundamental conceptions of the different orders of phenomena which furnish a solid basis to all combinations, and are not founded on any antecedent intellectual system. In such a study, speculation is our material, and not the application of it,—except where the application may happen to throw back light on its speculative origin. This is probably what Bacon meant by that First Philosophy which he declared to be an extract from the whole of Science, and which has been so differently and so strangely interpreted by his metaphysical commentators.

There can be no doubt that Man's study of nature must furnish the only basis of his action upon nature; for it is only by knowing the laws of phenomena, and thus being able to foresee them, that we can, in active life, set them to modify one another for our advantage. Our direct natural power over everything about us is extremely weak, and altogether disproportioned to our needs. Whenever we effect anything great, it is through a knowledge of natural laws, by which we can set one agent to work upon another,—even very weak modifying elements producing a change in the results of a large aggregate of causes. The relation of science to art may be summed up in a brief expression:

From Science comes Prevision: from Prevision comes Action.

We must not, however, fall into the error of our time, of regarding Science chiefly as a basis of Art. However great may be the services rendered to Industry by science, however true may be the saying that Knowledge is Power, we must never forget that the sciences have a higher destination still; and not only higher, but more direct—that of satisfying the craving of our understanding to know the laws of phenomena. To feel how deep and urgent this need is, we have only to consider for a moment the physiological effects of *consternation*, and to remember that the most terrible sensation we are capable of, is that which we experience when any phenomenon seems to arise in violation of the familiar laws of nature. This need of disposing facts in a comprehensible order (which is the proper object of all scientific theories) is so inherent in our organization, that if we could not satisfy it by positive conceptions, we must inevitably return to those theological and metaphysical explanations which had their origin in this very fact of human nature. It is this original tendency which acts as a preservative, in the minds of men of science, against the narrowness and incompleteness which the practical habits of our age are apt to produce. It is through this that we are able to maintain just and noble ideas of the importance and destination of the sciences; and if it were not thus, the human understanding would soon, as Condorcet has observed, come to a stand, even as to the practical applications for the sake of which higher things had been sacrificed; for, if the arts flow from science, the neglect of science must destroy the consequent arts. Some of the most important arts are derived from speculations pursued during long ages with a purely scientific intention. For instance, the ancient Greek geometers delighted themselves with beautiful speculations on Conic Sections; those speculations wrought, after a long series of generations, the renovation of astronomy; and out of this has the art of navigation attained a perfection which it never could have reached otherwise than through the speculative labors of Archimedes and Apollonius: so that, to use Condorcet's illustration, "the sailor who is preserved from shipwreck by the exact observation of the longitude, owes his life to a theory conceived two thousand years before by men of genius who had in view simply geometrical speculations."

Our business, it is clear, is with theoretical researches, letting alone their practical application altogether. Though we may conceive of a course of study which should unite the generalities of speculation and application, the time is not come for it. To say nothing of its vast extent, it would require preliminary achievements which have not yet been attempted. We must first be in possession of appropriate Special conceptions, formed according to scientific theories; and for these we have yet to wait. Meantime, an intermediate class is rising up, whose particular destination is to organize the relation of theory and practice; such as the engineers, who do not labor in the advancement of science, but who study it in its existing state, to apply it to practical purposes. Such classes are furnishing us with the elements of a future body of doctrine on the theories of the different arts. Already, Monge, in his view of descriptive geometry, has given us a general theory of the arts of construction. But we have as yet only a few scattered instances of this nature. The time will come when out of such results, a department of Positive philosophy may arise; but it will be in a distant future. If we remember that several sciences are implicated in every important art,—that, for instance, a true theory of Agriculture requires a combination of physiological, chemical, mechanical, and even astronomical and mathematical science,—it will be evident that true theories of the arts must wait for a large and equable development of these constituent sciences.

Abstract science.

Concrete science.

One more preliminary remark occurs, before we finish the prescription of our limits,—the ascertainment of our field of inquiry. We must distinguish between the two classes of Natural science; —the abstract or general, which have for their object the discovery of the laws which regulate phenomena in all conceivable cases: and the concrete, particular, or descriptive, which are sometimes called Natural sciences in a restricted sense, whose function it is to apply these laws to the actual history of existing beings. The first are fundamental; and our business is with them alone, as the second are derived, and however important, not rising into the rank of our subjects of contemplation. We shall treat of physiology, but not of botany and zoology, which are derived from it. We shall treat of chemistry, but not of mineralogy, which is secondary to it.—We may say of Concrete Physics, as these secondary sciences are called, the same thing that we said of theories of the arts,—that they require a preliminary knowledge of several sciences, and an advance of those sciences not yet achieved; so that, if there were no other reason, we must leave these secondary classes alone. At a future time Concrete Physics will have made progress, according to the development of Abstract Physics, and will afford a mass of less incoherent materials than those which it now presents. At present, too few of the students of these secondary sciences appear to be even aware that a due acquaintance with the primary sciences is requisite to all successful prosecution of their own.

We have now considered,

First, that science being composed of speculative knowledge and of practical knowledge, we have to deal only with the first; and

Second, that theoretical knowledge, or science properly so called, being divided into general and particular, or abstract and concrete science, we have again to deal only with the first.

Being thus in possession of our proper subject, duly prescribed, we may proceed to the ascertainment of the true order of the fundamental sciences.

Difficulty of classification.

This classification of the sciences is not so easy a matter as it may appear. However natural it may be, it will always involve something, if not arbitrary, at least artificial; and in so far, it will always involve imperfection. It is impossible to fulfil, quite rigorously, the object of presenting the sciences in their natural connection, and according to their mutual dependence, so as to avoid the smallest danger of being involved in a vicious circle. It is easy to show why.

Historical and dogmatic methods.

Every science may be exhibited under two methods or procedures, the Historical and the Dogmatic. These are wholly distinct from each other, and any other method can be nothing but some combination of these two. By the first method knowledge is presented in the same order in which it was actually obtained by the human mind, together with the way in which it was obtained. By the second, the system of ideas is presented as it might be conceived of at this day, by a mind which, duly prepared and placed at the right point of view, should begin to reconstitute the science as a whole. A new science must be pursued historically, the only thing to be done being to study in chronological order the different works which have contributed to the progress of the science. But when such materials have become recast to form a general system, to meet the demand for a more natural logical order, it is because the science is too far advanced for the historical order to be practicable or suitable. The more discoveries are made, the greater becomes the labor of the historical method of study, and the more effectual the dogmatic, because the new conceptions bring forward the earlier ones in a fresh light. Thus, the education of an ancient geometer consisted simply in the study, in their due order, of the very small number of original treatises then existing on the different parts of geometry. The writings of Archimedes and Apollonius were, in fact, about all. On the contrary, a modern geometer commonly finishes his education without having read a single original work dating further back than the most recent discoveries, which can not be known by any other means. Thus the Dogmatic Method is for ever superseding the Historical, as we advance to a higher position in science. If every mind had to pass through all the stages that every predecessor in the study had gone through, it is clear that, however easy it is to learn rather than invent, it would be impossible to effect the purpose of education,—to place the student on the vantage-ground gained by the labors of all the men who have gone before. By the dogmatic method this is done, even though the living student may have only an ordinary intellect, and the dead may have been men of lofty genius. By the dogmatic method therefore must every advanced science be attained, with so much of the historical combined with it as is rendered necessary by discoveries too recent to be studied elsewhere than in their own records. The only objection to the preference of the Dogmatic method is that it does not show how the science was attained; but a moment's reflection will show that this is the case also with the Historical method. To pursue a science historically is quite a different thing from learning the history of its progress. This last pertains to the study of human history, as we shall see when we reach the final division of this work. It is true that a science can not be completely understood without a knowledge of how it arose; and again, a dogmatic knowledge of any science is necessary to an understanding of its history; and therefore we shall notice, in treating of the fundamental sciences, the incidents of their origin, when distinct and illustrative; and we shall use their history, in a scientific sense, in our treatment of Social Physics; but the historical study, important, even essential, as it is, remains entirely distinct from the proper dogmatic study of science. These considerations, in this place, tend to define more precisely the spirit of our course of inquiry, while they more exactly determine the conditions under which we may hope to succeed in the construction of a true scale of the aggregate fundamental sciences. Great confusion would arise from any attempt to adhere strictly to historical order in our exposition of the sciences, for they have not all advanced at the same rate; and we must be for ever borrowing from each some fact to illustrate another, without regard to priority of origin. Thus, it is clear that, in the system of the sciences, astronomy must come before physics, properly so called: and yet, several branches of physics, above all, optics, are indispensable to the complete exposition of astronomy. Minor defects, if inevitable, can not invalidate a classification which, on the whole, fulfils the principal conditions of the case. They belong to what is essentially artificial in our division of intellectual labor. In the main, however, our classification agrees with the history of science; the more general and simple sciences actually occurring first and advancing best in human history, and being followed by the more complex and restricted, though all were, since the earliest times, enlarging simultaneously.

A simple mathematical illustration will precisely represent the difficulty of the question we have to resolve, while it will sum up the preliminary considerations we have just concluded.

We propose to classify the fundamental sciences. They are six, as we shall soon see. We can not make them less; and most scientific men would reckon them as more. Six objects admit of 720 different dispositions, or, in popular language, changes. Thus we have to choose the one right order (and there can be but one right) out of 720 possible ones. Very few of these have ever been proposed; yet we might venture to say that there is probably not one in favor of which some plausible reason might not be assigned; for we see the wildest divergences among the schemes which have been proposed,—the sciences which are placed by some at the head of the scale being sent by others to the further extremity. Our problem is, then, to find the one rational order, among a host of possible systems.

True principle of classification.

Now we must remember that we have to look for the principle of classification in the comparison of the different orders of phenomena, through which Science discovers the laws which are her object. What we have to determine is the real dependence of scientific studies. Now, this dependence can result only from that of the corresponding phenomena. All observable phenomena may be included within a very few natural categories, so arranged as that the study of each category may be grounded on the principal laws of the preceding, and serve as the basis of the next ensuing. This order is determined by the degree of simplicity, or, what comes to the same thing, of generality of their phenomena. Hence results their successive dependence, and the greater or lesser facility for being studied.

Generality.

Dependence.

It is clear, *à priori*, that the most simple phenomena must be the most general; for whatever is observed in the greatest number of cases is of course the most disengaged from the incidents of particular cases. We must begin then with the study of the most general or simple phenomena, going on successively to the more particular or complex. This must be the most methodical way, for this order of generality or simplicity fixes the degree of facility in the study of phenomena, while it determines the necessary connection of the sciences by the successive dependence of their phenomena. It is worthy of remark in this place that the most general and simple phenomena are the furthest removed from Man's ordinary sphere, and must thereby be studied in a calmer and more rational frame of mind than those in which he is more nearly implicated; and this constitutes a new ground for the corresponding sciences being developed more rapidly.

We have now obtained our rule. Next we proceed to our classification.

Inorganic and Organic phenomena.

We are first struck by the clear division of all natural phenomena into two classes—of inorganic and of organic bodies. The organized are evidently, in fact, more complex and less general than the inorganic, and depend upon them, instead of being depended on by them. Therefore it is that physiological study should begin with inorganic phenomena; since the organic include all the qualities belonging to them, with a special order added, viz., the vital phenomena, which belong to organization. We have not to investigate the nature of either; for the positive philosophy does not inquire into natures. Whether their natures be supposed different or the same, it is evidently necessary to separate the two studies of inorganic matter and of living bodies. Our classification will stand through any future decision as to the way in which living bodies are to be regarded; for, on any supposition, the general laws of inorganic physics must be established before we can proceed with success to the examination of a dependent class of phenomena.

I. INORGANIC.

1. Astronomy.

Each of these great halves of natural philosophy has subdivisions. Inorganic physics must, in accordance with our rule of generality and the order of dependence of phenomena, be divided into two sections—of celestial and terrestrial phenomena. Thus we have Astronomy, geometrical and mechanical, and Terrestrial Physics. The necessity of this division is exactly the same as in the former case.

Astronomical phenomena are the most general, simple, and abstract of all; and therefore the study of natural philosophy must clearly begin with them. They are themselves independent, while the laws to which they are subject influence all others whatsoever. The general effects of gravitation preponderate, in all terrestrial phenomena, over all effects which may be peculiar to them, and modify the original ones. It follows that the analysis of the simplest terrestrial phenomenon, not only chemical, but even purely mechanical, presents a greater complication than the most compound astronomical phenomenon. The most difficult astronomical question involves less intricacy than the simple movement of even a solid body, when the determining circumstances are to be computed. Thus we see that we must separate these two studies, and proceed to the second only through the first, from which it is derived.

2. Physics.

3. Chemistry.

In the same manner, we find a natural division of Terrestrial Physics into two, according as we regard bodies in their mechanical or their chemical character. Hence we have Physics, properly so called, and Chemistry. Again, the second class must be studied through the first. Chemical phenomena are more complicated than mechanical, and depend upon them, without influencing them in return. Every one knows that all chemical action is first submitted to the influence of weight, heat, electricity, etc., and presents moreover something which modifies all these. Thus, while it follows Physics, it presents itself as a distinct science.

II. ORGANIC.

Such are the divisions of the sciences relating to inorganic matter. An analogous division arises in the other half of Natural Philosophy—the science of organized bodies.

1. Physiology.

2. Sociology.

Here we find ourselves presented with two orders of phenomena; those which relate to the individual, and those which relate to the species, especially when it is gregarious. With regard to Man, especially, this distinction is fundamental. The last order of phenomena is evidently dependent on the first, and is more complex. Hence we have two great sections in organic physics—Physiology, properly so called, and Social Physics, which is dependent on it. In all Social phenomena we perceive the working of the physiological laws of the individual; and moreover something which modifies their effects, and which belongs to the influence of individuals over each other—singularly complicated in the case of the human race by the influence of generations on their successors. Thus it is clear that our social science must issue from that which relates to the life of the individual. On the other hand, there is no occasion to suppose, as some eminent physiologists have done, that Social Physics is only an appendage to physiology. The phenomena of the two are not identical, though they are homogeneous; and it is of high importance to hold the two sciences separate. As social conditions modify the operation of physiological laws, Social Physics must have a set of observations of its own.

It would be easy to make the divisions of the Organic half of Science correspond with those of the Inorganic, by dividing physiology into vegetable and animal, according to popular custom. But this distinction, however important in Concrete Physics (in that secondary and special class of studies before declared to be inappropriate to this work), hardly extends into those Abstract Physics with which we have to do. Vegetables and animals come alike under our notice, when our object is to learn the general laws of life—that is, to study physiology. To say nothing of the fact that the distinction grows ever fainter and more dubious with new discoveries, it bears no relation to our plan of research; and we shall therefore consider that there is only one division in the science of organized bodies.

Five Natural Sciences.

Thus we have before us Five fundamental Sciences in successive dependence—Astronomy, Physics, Chemistry, Physiology, and finally Social Physics. The first considers the most general, simple, abstract, and remote phenomena known to us, and those which affect all others without being affected by them. The last considers the most particular, compound, concrete phenomena, and those which are the most interesting to Man. Between these two, the degrees of speciality, of complexity, and individuality, are in regular proportion to the place of the respective sciences in the scale exhibited. This—casting out everything arbitrary—we must regard as the true filiation of the sciences; and in it we find the plan of this work.

Their filiation.

Filiation of their parts.

As we proceed, we shall find that the same principle which gives this order to the whole body of science arranges the parts of each science; and its soundness will therefore be freshly attested as often as it presents itself afresh. There is no refusing a principle which distributes the interior of each science after the same method with the aggregate sciences. But this is not the place in which to do more than indicate what we shall contemplate more closely hereafter. We must now rapidly review some of the leading properties of the hierarchy of science that has been disclosed.

Corroborations.

1. This classification follows the order of disclosure of sciences.

This gradation is in essential conformity with the order which has spontaneously taken place among the branches of natural philosophy, when pursued separately, and without any purpose of establishing such order. Such an accordance is a strong presumption that the arrangement is natural. Again, it coincides with the actual development of natural philosophy. If no leading science can be effectually pursued otherwise than through those which precede it in the scale, it is evident that no vast development of any science could take place prior to the great astronomical discoveries to which we owe the impulse given to the whole. The progression may since have been simultaneous; but it has taken place in the order we have recognised.

2 Solves heterogeneousness.

This consideration is so important that it is difficult to understand without it the history of the human mind. The general law which governs this history, as we have already seen, can not be verified, unless we combine it with the scientific gradation just laid down: for it is according to this gradation that the different human theories have attained in succession the theological state, the metaphysical, and finally the positive. If we do not bear in mind the law which governs progression, we shall encounter insurmountable difficulties; for it is clear that the theological or metaphysical state of some fundamental theories must have temporarily coincided with the positive state of others which precede them in our established gradation, and actually have at times coincided with them; and this must involve the law itself in an obscurity which can be cleared up only by the classification we have proposed.

3 Marks relative perfection in sciences.

Again, this classification marks, with precision, the relative perfection of the different sciences, which consists in the degree of precision of knowledge, and in the relation of its different branches. It is easy to see that the more general, simple, and abstract any phenomena are, the less they depend on others, and the more precise they are in themselves, and the more clear in their relations with each other. Thus, organic phenomena are less exact and systematic than inorganic; and of these again terrestrial are less exact and systematic than those of astronomy. This fact is completely accounted for by the gradation we have laid down; and we shall see as we proceed, that the possibility of applying mathematical analysis to the study of phenomena is exactly in proportion to the rank which they hold in the scale of the whole.

Defects are in us, not in science.

There is one liability to be guarded against, which we may mention here. We must beware of confounding the degree of precision which we are able to attain in regard to any science, with the certainty of the science itself. The certainty of science, and our precision in the knowledge of it, are two very different things, which have been too often confounded; and are so still, though less than formerly. A very absurd proposition may be very precise; as if we should say, for instance, that the sum of the angles of a triangle is equal to three right angles; and a very certain proposition may be wanting in precision in our statement of it; as, for instance, when we assert that every man will die. If the different sciences offer to us a varying degree of precision, it is from no want of certainty in themselves, but of our mastery of their phenomena.

4. Effect on Education.

The most interesting property of our formula of gradation is its effect on education, both general and scientific. This is its direct and unquestionable result. It will be more and more evident as we proceed, that no science can be effectually pursued without the preparation of a competent knowledge of the anterior sciences on which it depends. Physical philosophers can not understand Physics without at least a general knowledge of Astronomy; nor Chemists, without Physics and Astronomy; nor Physiologists, without Chemistry, Physics, and Astronomy; nor, above all, the students of Social philosophy, without a general knowledge of all the anterior sciences. As such conditions are, as yet, rarely fulfilled, and as no organization exists for their fulfilment, there is among us, in fact, no rational scientific education. To this may be attributed, in great part, the imperfection of even the most important sciences at this day. If the fact is so in regard to scientific education, it is no less striking in regard to general education. Our intellectual system can not be renovated till the natural sciences are studied in their proper order. Even the highest understandings are apt to associate their ideas according to the order in which they were received: and it is only an intellect here and there, in any age, which in its utmost vigor can, like Bacon, Descartes, and Leibnitz, make a clearance in their field of knowledge, so as to reconstruct from the foundation their system of ideas.

Effect on Method.

Such is the operation of our great law upon scientific education through its effect on Doctrine. We can not appreciate it duly without seeing how it affects Method.

As the phenomena which are homogeneous have been classed under one science, while those which belong to other sciences are heterogeneous, it follows that the Positive Method must be constantly modified in a uniform manner in the range of the same fundamental science, and will undergo modifications, different and more and more compound, in passing from one science to another. Thus, under the scale laid down, we shall meet with it in all its varieties; which could not happen if we were to adopt a scale which should not fulfil the conditions we have admitted. This is an all-important consideration; for if, as we have already seen, we can not understand the positive method in the abstract, but only by its application, it is clear that we can have no adequate conception of it but by studying it in its varieties of application. No one science, however well chosen, could exhibit it. Though the Method is always the same, its procedure is varied. For instance, it should be Observation with regard to one kind of phenomena, and Experiment with regard to another; and different kinds of experiment, according to the case. In the same way, a general precept, derived from one fundamental science, however applicable to another, must have its spirit preserved by a reference to its origin; as in the case of the theory of Classifications. The best idea of the Positive Method would, of course, be obtained by the study of the most primitive and exalted of the sciences, if we were confined to one; but this isolated view would give no idea of its capacity of application to others in a modified form. Each science has its own proper advantages; and without some knowledge of them all, no conception can be formed of the power of the Method.

Orderly study of sciences.

One more consideration must be briefly adverted to. It is necessary, not only to have a general knowledge of all the sciences, but to study them in their order. What can come of a study of complicated phenomena, if the student have not learned, by the contemplation of the simpler, what a Law is, what it is to Observe; what a Positive conception is; and even what a chain of reasoning is? Yet this is the way our young physiologists proceed every day—plunging into the study of living bodies, without any other preparation than a knowledge of a dead language or two, or at most a superficial acquaintance with Physics and Chemistry, acquired without any philosophical method, or reference to any true point of departure in Natural philosophy. In the same way, with regard to Social phenomena, which are yet more complicated, what can be effected but by the rectification of the intellectual instrument, through an adequate study of the range of anterior phenomena? There are many who admit this: but they do not see how to set about the work, nor understand the Method itself, for want of the preparatory study; and thus, the admission remains barren, and social theories abide in the theological or metaphysical state, in spite of the efforts of those who believe themselves positive reformers.

These, then, are the four points of view under which we have recognised the importance of a Rational and Positive Classification.

MATHEMATICS.

It can not but have been observed, that in our enumeration of the sciences there is a prodigious omission. We have said nothing of Mathematical science. The omission was intentional; and the reason is no other than the vast importance of mathematics. This science will be the first of which we shall treat. Meantime, in order not to omit from our sketch a department so prominent, we may indicate here the general results of the study we are about to enter upon.

A department.

A basis.

An instrument.

In the present state of our knowledge, we must regard Mathematics less as a constituent part of natural philosophy than as having been, since the time of Descartes and Newton, the true basis of the whole of natural philosophy; though it is, exactly speaking, both the one and the other. To us it is of less value for the knowledge of which it consists, substantial and valuable as that knowledge is, than as being the most powerful instrument that the human mind can employ in the investigation of the laws of natural phenomena.

A double science.

In due precision, Mathematics must be divided into two great sciences, quite distinct from each other—Abstract Mathematics, or the Calculus (taking the word in its most extended sense), and Concrete Mathematics, which is composed of General Geometry and of Rational Mechanics. The Concrete part is necessarily founded on the Abstract, and it becomes in its turn the basis of all natural philosophy; all the phenomena of the universe being regarded, as far as possible, as geometrical or mechanical.

Abstract mathematics an instrument.

Concrete mathematics a science.

The Abstract portion is the only one which is purely instrumental, it being simply an immense extension of natural logic to a certain order of deductions. Geometry and mechanics must, on the contrary, be regarded as true natural sciences, founded, like all others, on observation, though, by the extreme simplicity of their phenomena, they can be systematized to much greater perfection. It is this capacity which has caused the experimental character of their first principles to be too much lost sight of. But these two physical sciences have this peculiarity, that they are now, and will be more and more, employed rather as method than as doctrine.

Mathematics pre-eminent in the scale.

It needs scarcely to be pointed out that, in placing Mathematics at the head of Positive Philosophy, we are only extending the application of the principle which has governed our whole Classification. We are simply carrying back our principle to its first manifestation. Geometrical and Mechanical phenomena are the most general, the most simple, the most abstract of all,—the most irreducible to others, the most independent of them; serving, in fact, as a basis to all others. It follows that the study of them is an indispensable preliminary to that of all others. Therefore must Mathematics hold the first place in the hierarchy of the sciences, and be the point of departure of all Education, whether general or special. In an empirical way, this has hitherto been the custom,—a custom which arose from the great antiquity of mathematical science. We now see why it must be renewed on a rational foundation.

We have now considered, in the form of a philosophical problem, the rational plan of the study of the Positive Philosophy. The order that results is this; an order which of all possible arrangements is the only one that accords with the natural manifestation of all phenomena. MATHEMATICS, ASTRONOMY, PHYSICS, CHEMISTRY, PHYSIOLOGY, SOCIAL PHYSICS.

BOOK I.

MATHEMATICS.

CHAPTER I.

MATHEMATICS, ABSTRACT AND CONCRETE.

We are now to enter upon the study of the first of the Six great Sciences: and we begin by establishing the importance of the Positive Philosophy in perfecting the character of each science in itself.

Though Mathematics is the most ancient and the most perfect science of all, the general idea of it is far from being clearly determined. The definition of the science, and its chief divisions, have remained up to this time vague and uncertain. The plural form of the name (grammatically used as singular) indicates the want of unity in its philosophical character, as commonly conceived. In fact, it is only since the beginning of the last century that it could be conceived of as a whole; and since that time geometers have been too much engaged on its different branches, and in applying it to the most important laws of the universe, to have much attention left for the general system of the science. Now, however, the pursuit of its specialities is no longer so engrossing as to exclude us from the study of Mathematics in its unity. It has now reached a degree of consistency which admits of the effort to reduce its parts into a system, in preparation for further advance. The latest achievements of mathematicians have prepared the way for this by evidencing a character of unity in its principal parts which was not before known to exist. Such is eminently the spirit of the great author of the Theory of Functions and of Analytical Mechanics.

Description of Mathematics.

The common description of Mathematics, as *the science of Magnitudes*, or somewhat more positively, *the science which relates to the Measurement of Magnitudes*, is too vague and unmeaning to have been used but for want of a better. Yet the idea contained in it is just at bottom, and is even suffi-

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ciently extensive, if properly understood; but it needs precision and depth. It is important in such matters not to depart unnecessarily from notions generally admitted; and we will therefore see how, from this point of view, we can rise to such a definition of Mathematics as will be adequate to the importance, extent, and difficulty of the science.

Object of Mathematics.

Our first idea of *measuring* a magnitude is simply that of comparing the magnitude in question with another supposed to be known, which is taken for the *unit* of comparison among all others of the same kind. Thus, when we define mathematics as being the measurement of magnitudes, we give a very imperfect idea of it, and one which seems to bear no relation, in this respect, to any science whatever. We seem to speak only of a series of mechanical procedures, like a superposition of lines, for obtaining the comparison of magnitudes, instead of a vast chain of reasonings, inexhaustible by the intellect. Nevertheless, this definition has no other fault than not being deep enough. It does not mistake the real aim of mathematics, but it presents as direct an object which is usually indirect; and thus it misleads us as to the nature of the science. To rectify this, we must attend to a general fact, which is easily established—that the direct measurement of a magnitude is often an impossible operation; so that if we had no other means of doing what we want, we must often forego the knowledge we desire. We can rarely even measure a right line by another right line; and this is the simplest measurement of all. The very first condition of this is, that we should be able to traverse the line from one end to the other; and this can not be done with the greater number of the distances which interest us the most. We can not do it with the heavenly bodies, nor with the earth and any heavenly body, nor even with many distances on the earth; and again, the length must be neither too great nor too small, and it must be conveniently situated; and a line which could be easily measured if it were horizontal, becomes impracticable if vertical. There are so few lines capable of being directly measured with precision, that we are compelled to resort to artificial lines, created to admit of a direct determination, and to be the point of reference for all others. If there is difficulty about the measurement of lines, the embarrassment is much greater when we have to deal with surfaces, volumes, velocities, times, forces, etc., and in general with all other magnitudes susceptible of estimate, and, by their nature, difficult of direct measurement. It is the general fact of this difficulty, inherent in almost every case, which necessitates the formation of mathematical science; for, finding direct measurement so often impossible, we are compelled to devise means of doing it indirectly. Hence arose Mathematics.

General method.

The general method employed, and the only conceivable one, is to connect the magnitudes in question with some that can be directly determined, and thus to ascertain the former, through their relations with the latter. Such is the precise object of Mathematics, regarded as a whole. To form anything like a worthy idea of it, we must remember that the indirect determination of magnitudes may have many degrees of indirectness. It often happens that the magnitudes to which undetermined magnitudes are to be referred can not themselves be measured directly, and must themselves be made the subject of a prior process, and so on through a whole series; and thus, the mind is often obliged to establish a long course of intermediaries between the one and the other point of the inquiry—points which may appear at the outset to have no connection whatever.

Examples.

If this appears too abstract, it may become plain by a few examples. In observing a falling body, we are aware that two quantities are involved: the height from which the body falls, and the time occupied in its descent. These two quantities are connected, as they vary together, and together remain fixed. In the language of mathematicians, they are *functions* of each other. The measurement of one being impracticable, it is supplied by that of the other. By observing the time occupied by a stone in falling down a precipice, we can ascertain the height of the precipice as accurately as if we could measure it with a horizontal line. In another case, we may be able to know the height whence a body has fallen, and unable to observe the time with precision, and then we must have recourse to the inverse question,—to determine the time by the distance; as, for instance, if we were to inquire how long it would take a body to fall from the moon. In these cases, the question is very simple, supposing we do not complicate it with considerations of intensity of gravity, resistance of a fluid medium, etc. But, to enlarge the question, we must contemplate the phenomenon in its greatest generality by supposing the fall to be oblique, and taking into account all the principal circumstances. Then, instead of two variable quantities, simply connected, the phenomenon will present a considerable number,—the space traversed, whether in a vertical or horizontal direction; the time employed in traversing it; the velocity of the body at each point of its course; and even the intensity and direction of the impulse which sent it forth; and finally, in some cases, the resistance of the medium, and the intensity of gravity. All these quantities are so connected that each, in its turn, may be determined indirectly by means of the others, and thus we shall have as many mathematical inquiries as there are magnitudes coexisting in the phenomenon considered. Such a very simple change as this in the physical conditions of a problem may place a mathematical question, originally quite elementary, in the rank of those difficult questions whose complete and rigorous solution transcends the power of the human understanding.

Again—we may take a geometrical example. We want to determine a distance not directly measurable. We shall conceive of it as making a part of some *figure*, or system of lines of some sort, of which the other parts are directly measurable; let us say a tri angle (for this is the simplest, and to it all others are reducible). The distance in question is supposed to form a portion of a triangle, in which we are able to determine directly, either another side and two angles, or two sides and one angle. The knowledge required is obtained by the mathematical labor of deducing the unknown distance from the observed elements, by means of the relation between them. The process may, and commonly does, become highly complicated by the elements supposed to be known being themselves determinable only in an indirect manner, by the aid of fresh auxiliary systems, the number of which may be very considerable. The distance, once ascertained, will often enable us to obtain new quantities which will offer occasion for new mathematical questions. Thus, when we once know the distance of any object, the observation, simple and always possible, of its apparent diameter, may disclose to us, with certainty, however indirectly, its real dimensions; and at length, by a series of analogous inquiries, its surface, its volume, even its weight, and a multitude of other qualities which might have seemed out of the reach of our knowledge for ever. It is by such labors that Man has learned to know, not only the distances of the planets from the earth and from each other, but their actual magnitude—their true form, even to the inequalities on their surface, and (what seems much more out of his reach) their respective masses, their mean densities, and the leading circumstances of the fall of heavy bodies on their respective surfaces, etc. Through the power of mathematical theories, all this and very much more has been obtained by means of a very small number of straight lines, properly chosen, and a larger number of angles. We might even say, to describe the general bearing of the science in a sentence, that but for the fear of multiplying mathematical operations unnecessarily, and for the consequent necessity of reserving them for the determination of quantities which could not be measured directly, the knowledge of all magnitudes susceptible of precise estimate which can be offered by the various orders of phenomena, would be finally reducible to the immediate measurement of a single straight line, and of a suitable number of angles.

True definition of mathematics.

We can now define Mathematical science with precision. It has for its object the *indirect* measurement of magnitudes, and it proposes *to determine magnitudes by each other, according to the precise relations which exist between them.* Preceding definitions have given to Mathematics the character of an Art; this raises it at once to the rank of a true Science. According to this definition, the spirit of Mathematics consists in regarding as mutually connected all the quantities which can be presented by any phenomenon whatsoever, in order to deduce all from each other. Now, there is evidently no phenomenon which may not be regarded as affording such considerations. Hence results the naturally indefinite extent, and the rigorous logical universality of Mathematical science. As for its actual practical extent, we shall see what that is hereafter.

These explanations justify the name of Mathematics, applied to the science we are considering. By itself it signifies SCIENCE. The Greeks had no other, and we may call it *the* science; for its definition is neither more nor less (if we omit the specific notion of magnitudes) than the definition of all science whatsoever. All science consists in the co-ordination of facts; and no science could exist among isolated observations. It might even be said that Mathematics might enable us to dispense with all direct observation, by empowering us to deduce from the smallest possible number of immediate data the largest possible amount of results. Is not this the real use, both in speculation and in action, of the *laws* which we discover among natural phenomena? If so, Mathematics merely urges to the ultimate degree, in its own way, researches which every real science pursues, in various inferior degrees of its own sphere. Thus it is only through Mathematics that we can thoroughly understand what true science is. Here alone can we find in the highest degree simplicity and severity of scientific law, and such abstraction as the human mind can attain. Any scientific education setting forth from any other point, is faulty in its basis.

Thus far, we have viewed the science as a whole. We must now consider its primary division. The secondary divisions will be laid down afterward.

ITS TWO PARTS.

Their different objects.

Every mathematical solution spontaneously separates into two parts. The inquiry being, as we have seen, the determination of unknown magnitudes, through their relation to the known, the student must, in the first place, ascertain what these relations are, in the case under his notice. This first is the *Concrete* part of the inquiry. When it is accomplished, what remains is a pure question of numbers, consisting simply in a determination of unknown numbers when we know by what relation they are connected with known numbers. This second operation is the *Abstract* part of the inquiry. The primary division of Mathematics is therefore into two great sciences:—ABSTRACT MATHEMATICS, and CONCRETE MATHEMATICS. This division exists in all complete mathematical questions whatever, whether more or less simple.

Recurring to the simplest case of a falling body, we must begin by learning the relation between the height from which it falls and the time occupied in falling. As Geometers say, we must find the *equation* which exists between them. Till this is done, there is no basis for a computation. This ascertainment may be extremely difficult, and it is incomparably the superior part of the problem. The true scientific spirit is so modern, that, as far as we know, no one before Galileo had remarked the acceleration of velocity in a falling body, the natural supposition having been that the height was in uniform proportion to the time. This first inquiry issued in the discovery of the law of Galileo. The Concrete part being accomplished, the Abstract remains. We have ascertained that the spaces traversed in each second increase as the series of odd num bers, and we now have only the task of the computation of the height from the time, or of the time from the height; and this consists in finding that, by the established law, the first of these two quantities is a known multiple of the second power of the other; whence we may finally determine the value of the one when that of the other is given. In this instance the concrete question is the more difficult of the two. If the same phenomenon were taken in its greatest generality, the reverse would be the case. Take the two together, and they may be regarded as exactly equivalent in difficulty. The mathematical law may be easy to ascertain, and difficult to work; or it may be difficult to ascertain, and easy to work. In importance, in extent, and in difficulty, these two great sections of Mathematical Science will be seen hereafter to be equivalent.

Their different natures.

We have seen the difference in their objects. They are no less different in their nature.

The Concrete must depend on the character of the objects examined, and must vary when new phenomena present themselves: whereas, the Abstract is wholly independent of the nature of the objects, and is concerned only with their numerical relations. Thus, a great variety of phenomena may be brought under one geometrical solution. Cases which appear as unlike each other as possible may stand for one another under the Abstract process, which thus serves for all, while the Concrete process must be new in each case. Thus the Concrete process is Special, and the Abstract is General. The character of the Concrete is experimental, physical, phenomenal: while the Abstract is purely logical, rational. The Concrete part of every mathematical question is necessarily founded on consideration of the external world; while the Abstract part consists of a series of logical deductions. The equations being once found, in any case, it is for the understanding, without external aid, to educe the results which these equations contain.

We see how natural and complete this main division is. We will briefly prescribe the limits of each section.

Concrete Mathematics.

As it is the business of Concrete Mathematics to discover the equations of phenomena, we might suppose that it must comprehend as many distinct sciences as there are distinct categories of phenomena; but we are very far indeed from having discovered mathematical laws in all orders of phenomena. In fact, there are as yet only two great categories of phenomena whose equations are constantly known—Geometrical and Mechanical phenomena. Thus, the Concrete part of Mathematics consists of GEOMETRY and RATIONAL MECHANICS.

There is a point of view from which all phenomena might be included under these two divisions. All natural effects, considered statically or dynamically, might be referred to laws of extension or laws of motion. But this point of view is too high for us at present; and it is only in the regions of Astronomy, and, partially, of terrestrial Physics, that this vast transformation has taken place.

We will then proceed on the supposition that Geometry and Mechanics are the constituents of Concrete Mathematics.

Abstract Mathematics.

The nature of Abstract Mathematics is precisely determined. It is composed of what is called the *Calculus*, taking this word in its widest extension, which reaches from the simplest numerical operations to the highest combinations of transcendental analysis. Its proper object is to resolve all questions of numbers. Its starting-point is that which is the limit of Concrete Mathematics—the knowledge of the precise relations —that is, the equations—between different magnitudes which are considered simultaneously. The object of the Calculus, however indirect or complicated the relations may be, is to discover unknown quantities by the known. This science, though more advanced than any other, is, in reality, only at its beginning yet; but it is necessary, in order to define the nature of any science, to suppose it perfect. And the true character of the Calculus is what we have said.

From an historical point of view, Mathematical Analysis appears to have arisen out of the contemplation of geometrical and mechanical facts; but it is not the less independent of these sciences, logically speaking. Analytical ideas are, above all others, universal, abstract, and simple; and geometrical and mechanical conceptions are necessarily founded on them. Mathematical Analysis is therefore the true rational basis of the whole system of our positive knowledge. We can now also explain why it not only gives precision to our actual knowledge, but establishes a far more perfect co-ordination in the study of phenomena which allow of such an application. If a single analytical question, brought to an abstract solution, involves the *implicit* solution of a multitude of physical questions, the mind is enabled to perceive relations between phenomena apparently isolated, and to extract from them the quality which they have in common. To the wonder of the student, unsuspected relations arise between problems which, instead of being, as they appeared before, wholly unconnected, turn out to be identical. There appears to be no connection between the determination of the direction of a curve at each of its points and that of the velocity of a body at each moment of its variable motion; yet, in the eyes of the geometer, these questions are but one.

When we have seized the true general character of Mathematical Analysis, we easily see how perfect it is, in comparison with all other branches of our positive science. The perfection consists in the simplicity of the ideas contemplated; and not, as Condillac and others have supposed, in the conciseness and generality of the signs used as instruments of reasoning. The signs are of admirable use to work out the ideas, when once obtained; but, in fact, all the great analytical conceptions were formed without any essential aid from the signs. Subjects which are by their nature inferior in simplicity and generality can not be raised to logical perfection by any artifice of scientific language.

Extent of its domain.

We have now seen what is the object and what is the character of Mathematical Science. It remains for us to consider the extent of its domain.

Its universality.

We must first admit that, in a logical view, this science is necessarily and rigorously universal. There is no inquiry which is not finally reducible to a question of Numbers; for there is none which may not be conceived of as consisting in the determination of quantities by each other, according to certain relations. The fact is, we are always endeavoring to arrive at numbers, at fixed quantities, whatever may be our subject, however uncertain our methods, and however rough our results. Nothing can appear less like a mathematical inquiry than the study of living bodies in a state of disease; yet, in studying the cure of disease, we are endeavoring to ascertain the quantities of the different agents which are to modify the organism, in order to bring it to its natural state, admitting, as geometers do, for some of these quantities, in certain cases, values which are equal to zero, negative, or even contradictory. It is not meant that such a method can be actually followed in the case of complicated phenomena; but the logical extension of the science, which is what we are now considering, comprehends such instances as this.

Kant has divided human ideas into the two categories of quantity and quality, which, if true, would destroy the universality of Mathematics; but Descartes's fundamental conception of the relation of the concrete to the abstract in Mathematics abolishes this division, and proves that all ideas of quality are reducible to ideas of quantity. He had in view geometrical phenomena only; but his successors have included in this generalization, first, mechanical phenomena, and, more recently, those of heat. There are now no geometers who do not consider it of universal application, and admit that every phenomenon may be as logically capable of being represented by an equation as a curve or a motion, if only we were always capable (which we are very far from being) of first discovering, and then resolving it.

Its limitations.

The limitations of Mathematical science are not, then, in its nature. The limitations are in our intelligence: and by these we find the domain of the science remarkably restricted, in proportion as phenomena, in becoming special, become complex.

Though, as we have seen, every question may be conceived of as reducible to numbers, the reduction can not be made by us except in the case of the simplest and most general phenomena. The difficulty of finding the equation in the case of special, and therefore complex phenomena, soon becomes insurmountable, so that, at the utmost, it is only the phenomena of the first three classes,—that is, only those of Inorganic Physics,—that we can even hope to subject to the process. The properties of inorganic bodies are nearly invariable; and therefore, with regard to them, the first condition of mathematical inquiry can be fulfilled: the different quantities which they present may be resolved into fixed numbers; but the variableness of the properties of organic bodies is beyond our management. An inorganic body, possessing solidity, form, consistency, specific gravity, elasticity, etc., presents qualities which are within our estimate, and can be treated mathematically; but the case is altered when Chemical action is added to these. Complications and variations then enter into the question which at present baffle mathematical analysis. Hereafter, it may be discovered what fixed numbers exist in chemical combinations: but we are as yet very far from having any practical knowledge of them. Still further are we from being able to form such computations amidst the continual agitation of atoms which constitutes what we call *life*, and therefore from being able to carry mathematical analysis into the study of Physiology. By the rapidity of their changes, and their incessant numerical variations, vital phenomena are, practically, placed in opposition to mathematical processes. If we should desire to compute, in a single case, the most simple facts of a living body,—such as its mean density, its temperature, the velocity of its circulation, the proportion of elements which at any moment compose its solids or its fluids, the quantity of oxygen which it consumes in a given time, the amount of its absorptions or its exhalation,—and, yet more, the energy of its muscular force, the intensity of its impressions, etc., we must make as many observations as there are species or races, and varieties in each; we must measure the changes which take place in passing from one individual to another, and in the same individual, according to age, health, interior condition, surrounding circumstances perpetually varying, such as the constitution of the atmosphere, etc. It is clear that no mathematical precision can be attained amidst a complexity like this. Social phenomena, being more complicated still, are even more out of the question, as subjects for mathematical analysis. It is not that a mathematical basis does not exist in these cases, as truly as in phenomena which exhibit, in all clearness, the law of gravitation: but that our faculties are too limited for the working of problems so intricate. We are baffled by various phenomena of inorganic bodies, when they are very complex. For instance, no one doubts that meteorological phenomena are subject to mathematical laws, however little we yet know about them; but their multiplicity renders their observed results as variable and irregular as if each cause were free of all such conditions.

We find a second limitation in the number of conditions to be studied, even if we were sure of the mathematical law which governs each agent. Our feeble faculties could not grasp and wield such an aggregate of conditions, however certain might be our knowledge of each. In the simplest cases in which we desire to approximate the abstract to the concrete conditions, with any completeness,—as in the phenomenon of the flow of a fluid from a given orifice, by virtue of its gravity alone,—the difficulty is such that we are, as yet, without any mathematical solution of this very problem. The same is the case with the yet more simple instance of the movement of a solid projectile through a resisting medium.

To the popular mind it may appear strange, considering these facts, that we know so much as we do about the planets. But in reality, that class of phenomena is the most simple of all within our cognizance. The most complex problem which they present is the influence of a third body acting in the same way on two which are tending toward each other in virtue of gravitation; and this is a more simple question than any terrestrial problem whatever. We have, however, attained only approximate solutions in this case. And the high perfections to which solar astronomy has been brought by the use of mathematical science is owing to our having profited by those facilities that we may call accidental, which the favorable constitution of our planetary system presents. The planets which compose it are few; their masses are very unequal, and much less than that of the sun; they are far distant from each other; their forms are nearly spherical; their orbits are nearly circular, and only slightly inclined in relation to each other; and so on. Their perturbations are, in consequence, inconsiderable, for the most part; and all we have to do is usually to take into the account, together with the influence of the sun on each planet, the influence of one other planet, capable, by its size and its nearness, of occasioning perceptible derangements. If any of the conditions mentioned above had been different, though the law of gravitation had existed as it is, we might not at this day have discovered it. And if we were now to try to investigate Chemical phenomena by the same law, we should find a solution as impossible as it would be in astronomy, if the conditions of the heavenly bodies were such as we could not reduce to an analysis.

In showing that Mathematical analysis can be applied only to Inorganic Physics, we are not restricting its domain. Its rigorous universality, in a logical view, has been established. To pretend that it is practically applicable to the same extent would be merely to lead away the human mind from the true direction of scientific study, in pursuit of an impossible perfection. The most difficult sciences must remain, for an indefinite time, in that preliminary state which prepares for the others the time when they too may become capable of mathematical treatment. Our business is to study phenomena, in the characters and relations in which they present themselves to us, abstaining from introducing considerations of quantities, and mathematical laws, which it is beyond our power to apply.

We owe to Mathematics both the origin of Positive Philosophy and its Method. When this Method was introduced into the other sciences, it was natural that it should be urged too far. But each science modified the method by the operation of its own peculiar phenomena. Thus only could that true definitive character be brought out, which must prevent its being ever confounded with that of any other fundamental science.

The aim, character, and general relations of Mathematical Science have now been exhibited as fully as they could be in such a sketch as this. We must next pass in review the three great sciences of which it is composed,—the Calculus, Geometry, and Rational Mechanics.

CHAPTER II.

GENERAL VIEW OF MATHEMATICAL ANALYSIS.

ANALYSIS.

THE historical development of the Abstract portion of Mathematical science has, since the time of Descartes, been for the most part determined by that of the Concrete. Yet the Calculus in all its principal branches must be understood before passing on to Geometry and Mechanics. The Concrete portions of the science depend on the Abstract, which are wholly independent of them. We will now, therefore, proceed to a rapid review of the leading conceptions of the Analysis.

True idea of an equation.

First, however, we must take some notice of the general idea of an *equation*, and see how far it is from being the true one on which geometers proceed in practice; for without settling this point we can not determine, with any precision, the real aim and extent of abstract mathematics.

The business of concrete mathematics is to discover the equations which express the mathematical laws of the phenomenon under consideration; and these equations are the starting-point of the calculus, which must obtain from them certain quantities by means of others. It is only by forming a true idea of an equation that we can lay down the real line of separation between the concrete and the abstract part of mathematics.

It is giving much too extended a sense to the notion of an equation to suppose that it means every kind of relation of equality between *any* two functions of the magnitudes under consideration; for, if every equation is a relation of equality, it is far from being the case that, reciprocally, every relation of equality must be an equation of the kind to which analysis is, by the nature of the case, applicable. It is evident that this confusion must render it almost impossible to explain the difficulty we find in establishing the relation of the concrete to the abstract which meets us in every great mathematical question, taken by itself. If the word equation meant what we are apt to suppose, it is not easy to see what difficulty there could be, in general, in establishing the equations of any problem whatever. This ordinary notion of an equation is widely unlike what geometers understand in the actual working of the science.

According to my view, functions must themselves be divided into

Abstract and Concrete; the first of which alone can enter into true equations. Every equation is a relation of equality between two abstract functions of the magnitudes in question, including with the primary magnitudes all the auxiliary magnitudes which may be connected with the problem, and the introduction of which may facilitate the discovery of the equations sought.

This distinction may be established by both the *à priori* and *à posteriori* methods; by characterizing each kind of function, and by enumerating all the abstract functions yet known,—at least with regard to their elements.

Abstract functions.

A priori; Abstract functions express a mode of dependence between magnitudes which may be conceived between numbers alone, without the need of pointing out any phenomena in which it may be found realized; while Concrete functions are those whose expression requires a specified actual case of physics, geometry, mechanics, etc.

Concrete functions.

Most functions were concrete in their origin,—even those which are at present the most purely abstract; and the ancients discovered only through geometrical definitions elementary algebraic properties of functions, to which a numerical value was not attached till long afterward, rendering abstract to us what was concrete to the old geometers. There is another example which well exhibits the distinction just made—that of circular functions, both direct and inverse, which are still sometimes concrete, sometimes abstract, according to the point of view from which they are regarded.

A posteriori; the distinguishing character, abstract or concrete, of a function having been established, the question of any determinate function being abstract, and therefore able to enter into true analytical equations, becomes a simple question of fact, as we are acquainted with the elements which compose all the abstract functions at present known. We say we know them all, though analytical functions are infinite in number, because we are here speaking, it must be remembered, of the elements—of the simple, not of the compound. We have ten elementary formulas; and, few as they are, they may give rise to an infinite number of analytical combinations. There is no reason for supposing that there can never be more. We have more than Descartes had, and even Newton and Leibnitz; and our successors will doubtless introduce additions, though there is so much difficulty attending their augmentation, that we can not hope that it will proceed very far.

It is the insufficiency of this very small number of analytical elements which constitutes our difficulty in passing from the concrete to the abstract. In order to establish the equations of phenomena, we must conceive of their mathematical laws by the aid of functions composed of these few elements. Up to this point the question has been essentially concrete, not coming within the domain of the calculus. The difficulty of the passage from the concrete to the abstract in general consists in our having only these few analytical elements with which to represent all the precise relations which the whole range of natural phenomena afford to us. Amid their infinite variety, our conceptions must be far below the real difficulty; and especially because these elements of our analysis have been supplied to us by the mathematical consideration of the simplest phenomena of a geometrical origin, which can afford us, *à priori*, no rational guaranty of their fitness to represent the mathematical laws of all other classes of phenomena. We shall hereafter see how this difficulty of the relation of the concrete to the abstract has been diminished, without its being necessary to multiply the number of analytical elements.

Two parts of the Calculus.

Thus far we have considered the Calculus as a whole. We must now consider its divisions. These divisions we must call the *Algebraic Calculus*, or *Algebra*, and the *Arithmetical Calculus*, or *Arithmetic*, taking care to give them the most extended logical sense, and not the restricted one in which the terms are usually received.

Algebra.

It is clear that every question of Mathematical Analysis presents two successive parts, perfectly distinct in their nature. The first stage is the transformation of the proposed equations, so as to exhibit the mode of formation of unknown quantities by the known. This constitutes the *algebraic* question. Then ensues the task of finding the *values* of the *formulas* thus obtained. The values of the numbers sought are already represented by certain explicit functions of given numbers: these values must be determined; and this is the *arithmetical* question. Thus the algebraic and the arithmetical calculus differ in their object. They differ also in their view of quantities,—Algebra considering quantities in regard to their *relations*, and Arithmetic in regard to their *values*. In practice, it is not always possible, owing to the imperfection of the science of the calculus, to separate the processes entirely in obtaining a solution; but the radical difference of the two operations should never be lost sight of. *Algebra*, then, is the *Calculus of Function*, and *Arithmetic* the *Calculus of Values*.

Arithmetic.

We have seen that the division of the Calculus is into two branches. It remains for us to compare the two, in order to learn their respective extent, importance, and difficulty.

Arithmetic.

Its Extent.

The Calculus of Values, Arithmetic, appears at first to have as wide a field as Algebra, since as many questions might seem to arise from it as we can conceive different algebraic formulas to be valued. But a very simple reflection will show that it is not so. Functions being divided into simple and compound, it is evident that when we become able to determine the value of simple functions, there will be no difficulty with the compound. In the algebraic relation, a compound function plays a very different part from that of the elementary functions which constitute it; and this is the source of our chief analytical difficulties. But it is quite otherwise with the Arithmetical Calculus. Thus, the number of distinct arithmetical operations is indicated by that of the abstract elementary functions, which we have seen to be very few. The determination of the values of these ten functions necessarily affords that of all the infinite number comprehended in the whole of mathematical analysis: and there can be no new arithmetical operations otherwise than by the creation of new analytical elements, which must, in any case, for ever be extremely small. The domain of arithmetic then is, by its nature, narrowly restricted, while that of algebra is rigorously indefinite. Still, the domain of arithmetic is more extensive than is commonly represented; for there are many questions treated as incidental in the midst of a body of analytical researches, which, consisting of determinations of values, are truly arithmetical. Of this kind are the construction of a table of logarithms, and the calculation of trigonometrical tables, and some distinct and higher procedures; in short, every operation which has for its object the determination of the values of functions. And we must also include that part of the science of the Calculus which we call the Theory of Numbers, the object of which is to discover the properties inherent in different numbers, in virtue of their values, independent of any particular system of numeration. It constitutes a sort of transcendental arithmetic. Though the domain of arithmetic is thus larger than is commonly supposed, this Calculus of values will yet never be more than a point, as it were, in comparison with the calculus of functions, of which mathematical science essentially consists. This is evident, when we look into the real nature of arithmetical questions.

Its nature.

Determinations of values are, in fact, nothing else than real *transformations* of the functions to be valued. These transformations have a special end; but they are essentially of the same nature as all taught by analysis. In this view, the Calculus of values may be regarded as a supplement, and a particular application of the Calculus of functions, so that arithmetic disappears, at it were, as a distinct section in the body of abstract mathematics. To make this evident, we must observe that when we desire to determine the value of an unknown number whose mode of formation is given, we define and express that value in merely announcing the arithmetical question, already defined and expressed under a certain form; and that, in determining its value, we merely express it under another determinate form to which we are in the habit of referring the idea of each particular number by making it re-enter into the regular system of numeration. This is made clear by what happens when the mode of numeration is such that the question is its own answer; as, for instance, when we want to add together seven and thirty, and call the result seven-and-thirty. In adding other numbers, the terms are not so ready, and we transform the question; as when we add together twenty-three and fourteen: but not the less is the operation merely one of transformation of a question already defined and expressed. In this view, the *calculus of values* might be regarded as a particular application of the *calculus of functions*, arithmetic thereby disappearing, as a distinct section, from the domain of abstract mathematics. —And here we have done with the Calculus of values, and pass to the Calculus of functions, of which abstract mathematics is essentially composed.

Algebra.

We have seen that the difficulty of establishing the relation of the concrete to the abstract is owing to the insufficiency of the very small number of analytical elements that we are in possession of. The obstacle has been surmounted in a great number of important cases: and we will now see how the establishment of the equations of phenomena has been achieved.

Creation of new functions.

The first means of remedying the difficulty of the small number of analytical elements seems to be to create new ones. But a little consideration will show that this resource is illusory. A new analytical element would not serve unless we could immediately determine its value: but how can we determine the value of a function which is simple; that is, which is not formed by a combination of those already known? This appears almost impossible: but the introduction of another elementary abstract function into analysis supposes the simultaneous creation of a new arithmetical operation; which is certainly extremely difficult. If we try to proceed according to the method which procured us the elements we possess, we are left in entire uncertainty; for the artifices thus employed are evidently exhausted. We have thus no idea how to proceed to create new elementary abstract functions. Yet, we must not therefore conclude that we have reached the limit appointed by the powers of our understanding. Special improvements in mathematical analysis have yielded us some partial substitutes, which have increased our resources: but it is clear that the augmentation of these elements can not proceed but with extreme slowness. It is not in this direction, then, that the human mind has found its means of facilitating the establishment of equations.

Finding equations between auxiliary quantities.

This first method being discarded, there remains only one other. As it is impossible to find the equations directly, we must seek for corresponding ones between other auxiliary quantities, connected with the first according to a certain determinate law, and from the relation between which we may ascend to that of the primitive magnitudes. This is the fertile conception which we term the *transcendental analysis*, and use as our finest instrument for the mathematical exploration of natural phenomena.

This conception has a much larger scope than even profound geometers have hitherto supposed; for the auxiliary quantities resorted to might be derived, according to any law whatever, from the immediate elements of the question. It is well to notice this; because our future improved analytical resources may perhaps be found in a new mode of *derivation*. But, at present, the only auxiliary quantities habitually substituted for the primitive quantities in *transcendental analysis* are what are called—

1st, *infinitely small* elements, the *differentials* of different orders of those quantities, if we conceive of this analysis in the manner of Leibnitz: or

2d, the *fluxions*, the *limits* of the ratios of the simultaneous increments of the primitive quantities, compared with one another; or, more briefly, the *prime* and *ultimate* ratios of these increments, if we adopt the conception of Newton: or

3d, the *derivatives*, properly so called, of these quantities; that is, the coefficients of the different terms of their respective increments, according to the conception of Lagrange.

These conceptions, and all others that have been proposed, are by their nature identical. The various grounds of preference of each of them will be exhibited hereafter.

Division of the Calculus of functions.

We now see that the Calculus of functions, or Algebra, must consist of two distinct branches. The one has for its object the *resolution* of equations when they are directly established between the magnitudes in question: the other, setting out from equations (generally much more easy to form) between quantities indirectly connected with those of the problem, has to deduce, by invariable analytical procedures, the corresponding equations between the direct magnitudes in question;—bringing the problem within the domain of the preceding calculus.—It might seem that the transcendental analysis ought to be studied before the ordinary, as it provides the equations which the other has to resolve. But, though the transcendental is logically independent of the ordinary, it is best to follow the usual method of study, taking the ordinary first; for, the proposed questions always requiring to be completed by ordinary analysis, they must be left in suspense if the instrument of resolution had not been studied beforehand.

To ordinary analysis I propose to give the name of CALCULUS OF DIRECT FUNCTIONS. To transcendental analysis (which is known by the name of Infinitesimal Calculus, Calculus of fluxions and of fluents, Calculus of Vanishing quantities, the Differential and Integral Calculus, etc., according to the view in which it has been conceived) I shall give the title of CALCULUS OF INDIRECT FUNCTIONS. I obtain these terms by generalizing and giving precision to the ideas of Lagrange, and employ them to indicate the exact character of the two forms of analysis.

SECTION I.

ORDINARY ANALYSIS, OR CALCULUS OF DIRECT FUNCTIONS.

ALGEBRA is adequate to the solution of mathematical questions which are so simple that we can form directly the equations between the magnitudes considered, without its being necessary to bring into the problem, either in substitution or alliance, any system of auxiliary quantities derived from the primary. It is true, in the majority of important cases, its use requires to be preceded and prepared for by that of the calculus of indirect functions, by which the establishment of equations is facilitated: but though algebra then takes the second place, it is not the less a necessary agent in the solution of the question; so that the Calculus of direct functions must continue to be, by its nature, the basis of mathematical analysis. We must now, then, notice the rational composition of this calculus, and the degree of development it has attained.

Its object.

Its object being the resolution of equations (that is, the discovery of the mode of formation of unknown quantities by the known, according to the equations which exist between them), it presents as many parts as we can imagine distinct classes of equations; and its extent is therefore rigorously indefinite, because the number of analytical functions susceptible of entering into equations is illimitable, though, as we have seen, composed of a very small number of primitive elements.

Classification of Equations.

The rational classification of equations must evidently be determined by the nature of the analytical elements of which their numbers are composed. Accordingly, analysts first divide equations with one or more variables into two principal classes, according as they contain functions of only the first three of the ten couples, or as they include also either exponental or circular functions. Though the names of algebraic and transcendental functions given to these principal groups are inapt, the division between the corresponding equations is really enough, in so far as that the resolution of equations containing the transcendental functions is more difficult than that of algebraic equations. Hence the study of the first is extremely imperfect, and our analytical methods relate almost exclusively to the elaboration of the second.

Algebraic equations.

Our business now is with these Algebraic equations only. In the first place, we must observe that, though they may often contain *irrational* functions of the unknown quantities, as well as *rational* functions, the first case can always be brought under the second, by transformation more or less easy; so that it is only with the latter that analysts have had to occupy themselves, to resolve all the algebraic equations. As to their classification, the early method of classing them according to the number of their terms has been retained only for equations with two terms, which are, in fact, susceptible of a resolution proper to themselves. The classification by their degrees, long universally established, is eminently natural; for this distinction rigorously determines the greater or less difficulty of their resolution. The gradation can be independently, as well as practically exhibited: for the most general equation of each degree necessarily comprehends all those of the different inferior degrees, as must also the formula which determines the unknown quantity: and therefore, however slight we may, *à priori*, suppose the difficulty to be of the degree under notice, it must offer more and more obstacles, in proportion to the rank of the degree, because it is complicated in the execution with those of all the preceding degrees.

Algebraic resolution of equations.

This increase of difficulty is so great, that the resolution of algebraic equations is as yet known to us only in the first four degrees. In this respect, algebra has advanced but little since the labors of Descartes and the Italian analysts of the sixteenth century; though there has probably not been a single geometer for two centuries past who has not striven to advance the resolution of equations. The general equation of the fifth degree has itself, thus far, resisted all attempts. The formula of the fourth degree is so difficult as to be almost inapplicable; and analysts, while by no means despairing of the resolution of equations of the fifth, and even higher degrees, being obtained, have tacitly agreed to give up such researches.

The only question of this kind which would be of eminent importance, at least in its logical relations, would be the general resolution of algebraic equations of any degree whatever. But the more we ponder this subject, the more we are led to suppose, with Lagrange, that it exceeds the scope of our understandings. Even if the requisite formula could be obtained, it could not be usefully applied, unless we could simplify it, without impairing its generality, by the introduction of a new class of analytical elements, of which we have as yet no idea. And, besides, if we had obtained the resolution of algebraic equations of any degree whatever, we should still have treated only a very small part of algebra, properly so called; that is, of the calculus of direct functions, comprehending the resolution of all the equations that can be formed by the analytical functions known to us at this day. Again, we must remember that by a law of our nature, we shall always remain below the difficulty of science, our means of conceiving of new questions being always more powerful than our resources for resolving them; in other words, the human mind being more apt at imagining than at reasoning. Thus, if we had resolved all the analytical equations now known, and if to do this, we had found new analytical elements, these again would introduce classes of equations of which we now know nothing; and so, however great might be the increase of our knowledge, the imperfection of our algebraic science would be perpetually reproduced.

Our existing knowledge.

The methods that we have are, the complete resolution of the equations of the first four degrees; of any binomial equations; of certain special equations of the superior degrees; and of a very small number of exponential, logarithmic, and circular equations. These elements are very limited; but geometers have succeeded in treating with them a great number of important questions in an admirable manner. The improvements introduced within a century into mathematical analysis have contributed more to render the little knowledge that we have immeasurably useful, than to increase it.

Numerical resolution of equations.

To fill up the vast gap in the resolution of algebraic equations of the higher degrees, analysts have had recourse to a new order of questions,—to what they call the *numerical resolution* of equations. Not being able to obtain the real algebraic formula, they have sought to determine at least the *value* of each unknown quantity for such or such a designated system of particular values attributed to the given quantities. This operation is a mixture of algebraic with arithmetical questions; and it has been so cultivated as to be rendered possible in all cases, for equations of any degree and even of any form. The methods for this are now sufficiently general; and what remains is to simplify them so as to fit them for regular application. While such is the state of algebra, we have to endeavor so to dispose the questions to be worked as require finally only this *numerical* resolution of the equations. We must not forget however that this is very imperfect algebra; and it is only isolated, or truly final questions (which are very few), that can be brought finally to depend upon only the *numerical* resolution of equations. Most questions are only preparatory,—a first stage of the solution of other questions; and in these cases it is evidently not the *value* of the unknown quantity that we want to discover, but the *formula* which exhibits its derivation. Even in the most simple questions, when this numerical resolution is strictly sufficient, it is not the less a very imperfect method. Because we cannot abstract and treat separately the algebraic part of the question, which is common to all the cases which result from the mere variation of the given numbers, we are obliged to go over again the whole series of operations for the slightest change that may take place in any one of the quantities concerned.

Thus is the calculus of direct functions at present divided into two parts, as it is employed for the algebraic or the numerical resolution of equations. The first, the only satisfactory one, is unfortunately very restricted, and there is little hope that it will ever be otherwise: the second, usually insufficient, has at least the advantage of a much greater generality. They must be carefully distinguished in our minds, on account of their different objects, and therefore of the different ways in which quantities are considered by them. Moreover, there is, in regard to their methods, an entirely different procedure in their rational distribution. In the first part, we have nothing to do with the *values* of the unknown quantities, and the division must take place according to the nature of the equations which we are able to resolve; whereas in the second, we have nothing to do with the *degrees* of the equations, as the methods are applicable to equations of any degree whatever; but the concern is with the numerical character of the *values* of the unknown quantities.

The Theory of equations.

These two parts, which constitute the immediate object of the Calculus of direct functions, are subordinated to a third, purely speculative, from which both derive their most effectual resources, and which has been very exactly designated by the general name of *Theory of Equations*, though it relates, as yet, only to *algebraic* equations. The numerical resolution of equations has, on account of its generality, special need of this rational foundation.

Two orders of question divide this important department of algebra between them; first, those which relate to the composition of equations, and then those that relate to their transformation: the business of these last being to modify the roots of an equation without knowing them, according to any given law, provided this law is uniform in relation to all these roots.

One more theory remains to be noticed, to complete our rapid exhibition of the different essential parts of the calculus of direct functions. This theory, which relates to the transformation of functions into series by the aid of what is called the Method of indeterminate Coefficients, is one of the most fertile and important in algebra. This eminently analytical method is one of the most remarkable discoveries of Descartes. The invention and development of the infinitesimal calculus, for which it might be very happily substituted in some respects, has undoubtedly deprived it of some of its importance; but the growing extension of the transcendental analysis has, while lessening its necessity, multiplied its applications and enlarged its resources; so that, by the useful combination of the two theories, the employment of the method of indeterminate coefficients has become much more extensive than it was even before the formation of the calculus of indirect functions.

Method of indeterminate Coefficients.

I have now completed my sketch of the Calculus of Direct Functions. We must next pass on to the more important and extensive branch of our science, the Calculus of Indirect Functions.

SECTION II.

TRANSCENDENTAL ANALYSIS, OR CALCULUS OF INDIRECT FUNCTIONS.

Three principal views.

We referred (p. 65) in a former section to the views of the transcendental analysis presented by Leibnitz, Newton, and Lagrange. We shall see that each conception has advantages of its own, that all are finally equivalent, and that no method has yet been found which unites their respective characteristics. Whenever the combination takes place, it will probably be by some method founded on the conception of Lagrange. The other two will then offer only an historical interest; and meanwhile, the science must be regarded as in a merely provisional state, which requires the use of all the three conceptions at the same time; for it is only by the use of them all that an adequate idea of the analysis and its applications can be formed. The vast extent and difficulty of this part of mathematics, and its recent formation, should prevent our being at all surprised at the existing want of system. The conception which will doubtless give a fixed and uniform character to the science has come into the hands of only one new generation of geometers since its creation; and the intellectual habits requisite to perfect it have not been sufficiently formed.

History.

The first germ of the infinitesimal method (which can be conceived of independently of the Calculus) may be recognised in the old Greek *Method of Exhaustions*, employed to pass from the properties of straight lines to those of curves. The method consisted in substituting for the curve the auxiliary consideration of a polygon, inscribed or circumscribed, by means of which the curve itself was reached, the limits of the primitive ratios being suitably taken. There is no doubt of the filiation of ideas in this case; but there was in it no equivalent for our modern methods; for the ancients had no logical and general means for the determination of these limits, which was the chief difficulty of the question. The task remaining for modern geometers was to generalize the conception of the ancients, and, considering it in an abstract manner, to reduce it to a system of calculation, which was impossible to them.

Lagrange justly ascribes to the great geometer Fermat the first idea in this new direction. Fermat may be regarded as having initiated the direct formation of transcendental analysis by his method for the determination of *maxima* and *minima*, and for the finding of *tangents*, in which process he introduced auxiliaries which he afterward suppressed as null when the equations obtained had undergone certain suitable transformations. After some modifications of the ideas of Fermat in the intermediate time, Leibnitz stripped the process of some complications, and formed the analysis into a general and distinct calculus, having its own notation: and Leibnitz is thus the creator of transcendental analysis, as we employ it now. This pre-eminent discovery was so ripe, as all great conceptions are at the hour of their advent, that Newton had at the same time, or rather earlier, discovered a method exactly equivalent, regarding the analysis from a different point of view, much more logical in itself, but less adapted than that of Leibnitz to give all practicable extent and facility to the fundamental method. Lagrange afterward, discarding the heterogeneous considerations which had guided Leibnitz and Newton, reduced the analysis to a purely algebraic system, which only wants more aptitude for application.

We will notice the three methods in their order.

METHOD OF LEIBNITZ.

The method of Leibnitz consists in introducing into the calculus, in order to facilitate the establishment of equations, the infinitely small elements or *differentials* which are supposed to constitute the quantities whose relations we are seeking. There are relations between these differentials which are simpler and more discoverable than those of the primitive quantities: and by these we may afterward (through a special calculus employed to eliminate these auxiliary infinitesimals) recur to the equations sought, which it would usually have been impossible to obtain directly.

This indirect analysis may have various degrees of indirectness; for, when there is too much difficulty in forming the equation between the differentials of the magnitudes under notice, a second application of the method is required, the differentials being now treated as new primitive quantities, and a relation being sought between *their* infinitely small elements, or *second differentials*, and so on; the same transformation being repeated any number of times, provided the whole number of auxiliaries be finally eliminated.

It may be asked by novices in these studies, how these auxiliary quantities can be of use while they are of the same species with the magnitudes to be treated, seeing that the greater or less value of any quantity can not affect any inquiry which has nothing to do with value at all. The explanation is this. We must begin by distinguishing the different orders of infinitely small quantities, obtaining a precise idea of this by considering them as being either the successive powers of the same primitive infinitely small quantity, or as being quantities which may be regarded as having finite ratios with these powers; so that, for instance, the second or third or other differentials of the same variable are classed as infinitely small quantities of the second, third or other order, because it is easy to exhibit in them finite multiples of the second, third, or other powers of a certain first differential. These preliminary ideas being laid down, the spirit of the infinitesimal analysis consists in constantly neglecting the infinitely small quantities in comparison with finite quantities; and generally the infinitely small quantities of any order whatever in comparison with all those of an inferior order. We see at once how such a power must facilitate the formation of equations between the differentials of quantities, since we can substitute for these differentials such other elements as we may choose, and as will be more simple to treat, only observing the condition that the new elements shall differ from the preceding only by quantities infinitely small in relation to them. It is thus that it becomes possible in geometry to treat curved lines as composed of an infinity of rectilinear elements, and curved surfaces as formed of plane elements; and, in mechanics, varied motions as an infinite series of uniform motions, succeeding each other at infinitely small intervals of time. Such a mere hint as this of the varied application of this method may give some idea of the vast scope of the conception of transcendental analysis, as formed by Leibnitz. It is, beyond all question, the loftiest idea ever yet attained by the human mind.

It is clear that this conception was necessary to complete the basis of mathematical science, by enabling us to establish, in a broad and practical manner, the relation of the concrete to the abstract. In this respect, we must regard it as the necessary complement of the great fundamental idea of Descartes on the general analytical representation of natural phenomena; an idea which could not be duly estimated or put to use till after the formation of the infinitesimal analysis.

This analysis has another property besides that of facilitating the study of the mathematical laws of all phenomena, and perhaps not less important than that. The differential formulas exhibit an extreme generality, expressing in a single equation each determinate phenomenon, however varied may be the subjects to which it belongs. Thus, one such equation gives the tangents of all curves, another their rectifications, a third their quadratures; and, in the same way, one invariable formula expresses the mathematical law of all variable motion; and one single equation represents the distribution of heat in any body, and for any case. This remarkable generality is the basis of the loftiest views of the geometers. Thus, this analysis has not only furnished a general method for forming equations indirectly which could not have been directly discovered, but it has introduced a new order of more natural laws for our use in the mathematical study of natural phenomena, enabling us to rise at times to a perception of positive approximations between classes of wholly different phenomena, through the analogies presented by the differential expressions of their mathematical laws. In virtue of this second property of the analysis, the entire system of an immense science, like geometry or mechanics, has submitted to a condensation into a small number of analytical formulas, from which the solution of all particular problems can be deduced, by invariable rules.

Generality of the formulas.

This beautiful method is, however, imperfect in its logical basis. At first, geometers were naturally more intent upon extending the discovery and multiplying its applications than upon establishing the logical foundation of its processes. It was enough, for some time, to be able to produce, in answer to objections, unhoped-for solutions of the most difficult problems. It became necessary, however, to recur to the basis of the new analysis, to establish the rigorous exactness of the processes employed, notwithstanding their apparent breaches of the ordinary laws of reasoning. Leibnitz himself failed to justify his conception, giving, when urged, an answer which represented it as a mere approximative calculus, the successive operations of which might, it is evident, admit an augmenting amount of error. Some of his successors were satisfied with showing that its results accorded with those obtained by ordinary algebra, or the geometry of the ancients, reproducing by these last some solutions which could be at first obtained only by the new method. Some, again, demonstrated the conformity of the new conception with others; that of Newton especially, which was unquestionably exact. This afforded a practical justification: but, in a case of such unequalled importance, a logical justification is also required,—a direct proof of the necessary rationality of the infinitesimal method. It was Carnot who furnished this at last, by showing that the method was founded on the principle of the necessary compensation of errors. We can not say that all the logical scaffolding of the infinitesimal method may not have a merely provisional existence, vicious as it is in its nature:

Justification of the Method.

but, in the present state of our knowledge, Carnot's principle of the necessary compensation of errors is of more importance, in legitimating the analysis of Leibnitz, than is even yet commonly supposed. His reasoning is founded on the conception of infinitesimal quantities indefinitely decreasing, while those from which they are derived are fixed. The infinitely small errors introduced with the auxiliaries can not have occasioned other than infinitely small errors in all the equations; and when the relations of finite quantities are reached, these relations must be rigorously exact, since the only errors then possible must be finite ones, which can not have entered: and thus the finite equations become perfect. Carnot's theory is doubtless more subtile than solid; but it has no other radical logical vice than that of the infinitesimal method itself, of which it is, as it seems to me, the natural development and general explanation; so that it must be adopted as long as that method is directly employed.

The philosophical character of the transcendental analysis has now been sufficiently exhibited to allow of my giving only the principal idea of the other two methods.

NEWTON'S METHOD.

Newton offered his conception under several different forms in succession. That which is now most commonly adopted, at least on the continent, was called by himself, sometimes the *Method of prime and ultimate Ratios*, sometimes the *Method of Limits*, by which last term it is now usually known.

Method of limits.

Under this method, the auxiliaries introduced are the limits of the ratios of the simultaneous increments of the primitive quantities; or, in other words, the final ratios of these increments; limits or final ratios which we can easily show to have a determinate and finite value. A special calculus, which is the equivalent of the infinitesimal calculus, is afterward employed, to rise from the equations between these limits to the corresponding equations between the primitive quantities themselves.

The power of easy expression of the mathematical laws of phenomena given by this analysis arises from the calculus applying, not to the increments themselves of the proposed quantities, but to the limits of the ratios of those increments; and from our being therefore able always to substitute for each increment any other magnitude more easy to treat, provided their final ratio is the ratio of equality; or, in other words, that the limit of their ratio is unity. It is clear, in fact, that the calculus of limits can be in no way affected by this substitution. Starting from this principle, we find nearly the equivalent of the facilities offered by the analysis of Leibnitz, which are merely considered from another point of view. Thus, curves will be regarded as the limits of a series of rectilinear polygons, and variable motions as the limits of an aggregate of uniform motions of continually nearer approximation, etc., etc. Such is, in substance, Newton's conception; or rather, that which Maclaurin and D'Alembert have offered as the most rational basis of the transcendental analysis, in the endeavor to fix and arrange Newton's ideas on the subject.

Fluxions and fluents.

Newton had another view, however, which ought to be presented here, because it is still the special form of the calculus of indirect functions commonly adopted by English geometers; and also, on account of its ingenious clearness in some cases, and of its having furnished the notation best adapted to this manner of regarding the transcendental analysis. I mean the Calculus of *fluxions* and of *fluents*, founded on the general notion of *velocities*.

To facilitate the conception of the fundamental idea, let us conceive of every curve as generated by a point affected by a motion varying according to any law whatever. The different quantities presented by the curve, the abscissa, the ordinate, the arc, the area, etc., will be regarded as simultaneously produced by successive degrees during this motion. The *velocity* with which each one will have been described will be called the *fluxion* of that quantity, which inversely would have been called its *fluent*. Henceforth, the transcendental analysis will according to this conception, consist in forming directly the equations between the fluxions of the proposed quantities, to deduce from them afterward, by a special Calculus, the equations between the fluents themselves. What has just been stated respecting curves may evidently be transferred to any magnitudes whatever, regarded, by the help of a suitable image, as some being produced by the motion of others. This method is evidently the same with that of limits complicated with the foreign idea of motion. It is, in fact, only a way of representing, by a comparison derived from mechanics, the method of prime and ultimate ratios, which alone is reducible to a calculus. It therefore necessarily admits of the same general advantages in the various principal applications of the transcendental analysis, without its being requisite for us to offer special proofs of this.

LAGRANGE'S METHOD.

Lagrange's conception consists in its admirable simplicity, in considering the transcendental analysis to be a great algebraic artifice, by which, to facilitate the establishment of equations, we must introduce, in the place of or with the primitive functions, their *derived* functions; that is, according to the definition of Lagrange, the coefficient of the first term of the increment of each function, arranged according to the ascending powers of the increment of its variable. The Calculus of indirect functions, properly so called, is destined here, as well as in the conceptions of Leibnitz and Newton, to eliminate these derivatives, employed as auxiliaries, to deduce from their relations the corresponding equations between the primitive magnitudes. The transcendental analysis is then only a simple, but very considerable extension of ordinary analysis. It has long been a common practice with geometers to introduce, in analytical investigations, in the place of the magnitudes in question, their different powers, or their logarithms, or their sines, etc., in order to simplify the equations, and even to obtain them more easily. Successive *derivation* is a general artifice of the same nature, only of greater extent, and commanding in consequence, much more important resources for this common object.

But, though we may easily conceive, *à priori*, that the auxiliary use of these derivatives *may* facilitate the study of equations, it is not easy to explain why it *must* be so under this method of derivation, rather than any other transformation. This is the weak side of Lagrange's great idea. We have not yet become able to lay hold of its precise advantages, in an abstract manner, and without recurrence to the other conceptions of the transcendental analysis. These advantages can be established only in the separate consideration of each principal question; and this verification becomes laborious, in the treatment of a complex problem.

Other theories have been proposed, such as Euler's *Calculus of vanishing quantities:* but they are merely modifications of the three just exhibited. We must next compare and estimate these methods; and in the first place observe their perfect and necessary conformity.

Identity of the three methods.

Considering the three methods in regard to their destination, independently of preliminary ideas, it is clear that they all consist in the same general logical artifice; that is, the introduction of a certain system of auxiliary magnitudes uniformly correlative with those under investigation; the auxiliaries being substituted for the express object of facilitating the analytical expression of the mathematical laws of phenomena, though they must be finally eliminated by the help of a special calculus. It was this which determined me to define the transcendental analysis as the Calculus of indirect functions, in order to mark its true philosophical character, while excluding all discussion about the best manner of conceiving and applying it. Whatever may be the method employed, the general effect of this analysis is to bring every mathematical question more speedily into the domain of the calculus, and thus to lessen considerably the grand difficulty of the passage from the concrete to the abstract. We can not hope that the Calculus will ever lay hold of all questions of natural philosophy—geometrical, mechanical, thermological, etc.—from their birth. That would be a contradiction. In every problem there must be a certain preliminary operation before the calculus can be of any use, and one which could not by its nature be subjected to abstract and invariable rules:—it is that which has for its object the establishment of equations, which are the indispensable point of departure for all analytical investigations. But this preliminary elaboration has been remarkably simplified by the creation of the transcendental analysis, which has thus hastened the moment at which general and abstract processes may be uniformly and exactly applied to the solution, by reducing the operation to finding the equations between auxiliary magnitudes, whence the Calculus leads to equations directly relating to the proposed magnitudes, which had formerly to be established directly. Whether these indirect equations are *differential* equations, according to Leibnitz, or equations of *limits*, according to Newton, or *derived* equations, according to Lagrange, the general procedure is evidently always the same. The coincidence is not only in the result but in the process; for the auxiliaries introduced are really identical, being only regarded from different points of view. The conceptions of Leibnitz and Newton consist in making known in any case two general necessary properties of the derived function of Lagrange. The transcendental analysis, then, examined abstractly and in its principle, is always the same, whatever conception is adopted; and the processes of the Calculus of indirect functions are necessarily identical in these different methods, which must therefore, under any application whatever, lead to rigorously uniform results.

Their comparative value.

If we endeavor to estimate their comparative value, we shall find in each of the three conceptions advantages and inconveniencies which are peculiar to it, and which prevent geometers from adhering to any one of them, as exclusive and final.

The method of Leibnitz has eminently the advantage in the rapidity and ease with which it effects the formation of equations between auxiliary magnitudes. We owe to its use the high perfection attained by all the general theories of geometry and mechanics. Whatever may be the speculative opinions of geometers as to the infinitesimal method, they all employ it in the treatment of any new question. Lagrange himself, after having reconstructed the analysis on a new basis, rendered a candid and decisive homage to the conception of Leibnitz, by employing it exclusively in the whole system of his 'Analytical Mechanics.' Such a fact needs no comment. Yet we are obliged to admit, with Lagrange, that the conception of Leibnitz is radically vicious in its logical relations. He himself declared the notion of infinitely small quantities to be a *false idea:* and it is in fact impossible to conceive of them clearly, though we may sometimes fancy that we do. This false idea bears, to my mind, the characteristic impress of the metaphysical age of its birth and tendencies of its originator. By the ingenious principle of the compensation of errors, we may, as we have already seen, explain the necessary exactness of the processes which compose the method; but it is a radical inconvenience to be obliged to indicate, in Mathematics, two classes of reasonings so unlike, as that the one order are perfectly rigorous, while by the others we designedly commit errors which have to be afterward compensated. There is nothing very logical in this; nor is anything obtained by pleading, as some do, that this method can be made to enter into that of limits, which is logically irreproachable. This is eluding the difficulty, and not resolving it; and besides, the advantages of this method, its ease and rapidity, are almost entirely lost under such a transformation. Finally, the infinitesimal method exhibits the very serious defect of breaking the unity of abstract mathematics by creating a transcendental analysis founded upon principles widely different from those which serve as a basis to ordinary analysis. This division of analysis into two systems, almost wholly independent, tends to prevent the formation of general analytical conceptions. To estimate the consequences duly, we must recur, in thought, to the state of the science before Lagrange had established a general and complete harmony between these two great sections.

Newton's conception is free from the logical objections imputable to that of Leibnitz. The notion of *limits* is in fact remarkable for its distinctness and precision. The equations are, in this case, regarded as exact from their origin; and the general rules of reasoning are as constantly observed as in ordinary analysis. But it is weak in resources, and embarrassing in operation, compared with the infinitesimal method. In its applications, the relative inferiority of this theory is very strongly marked. It also separates the ordinary and transcendental analysis, though not so conspicuously as the theory of Leibnitz. As Lagrange remarked, the idea of *limits*, though clear and exact, is not the less a foreign idea, on which analytical theories ought not to be dependent.

This perfect unity of analysis, and a purely abstract character in the fundamental ideas, are found in the conception of Lagrange, and there alone. It is, therefore, the most philosophical of all. Discarding every heterogeneous consideration, Lagrange reduced the transcendental analysis to its proper character,—that of presenting a very extensive class of analytical transformations, which facilitate, in a remarkable degree, the expression of the conditions of the various problems. This exhibits the conception as a simple extension of ordinary analysis. It is a superior algebra. All the different parts of abstract mathematics, till then so incoherent, might be from that moment conceived of as forming a single system. This philosophical superiority marks it for adoption as the final theory of transcendental analysis; but it presents too many difficulties, in its application, in comparison with the others, to admit of its exclusive preference at present. Lagrange himself had great difficulty in rediscovering, by his own method, the principal results already obtained by the infinitesimal method, on general questions in geometry and mechanics; and we may judge by that what obstacles would occur in treating in the same way questions really new and important. Though Lagrange, stimulated by difficulty, obtained results in some cases which other men would have despaired of, it is not the less true that his conception has thus far remained, as a whole, essentially unsuited to applications.

The result of such a comparison of these three methods is the conviction that, in order to understand the transcendental analysis thoroughly, we should not only study it in its principles according to all these conceptions, but should accustom ourselves to employ them all (and especially the first and last) almost indifferently, in the solution of all important questions, whether of the calculus of indirect functions in itself, or of its applications. In all the other departments of mathematical science, the consideration of different methods for a single class of questions may be useful, apart from the historical interest which it presents; but it is not indispensable. Here, on the contrary, it is strictly indispensable. Without it there can be no philosophical judgment of this admirable creation of the human mind; nor any success and facility in the use of this powerful instrument.

THE DIFFERENTIAL AND INTEGRAL CALCULUS.

Its Two Parts.

The Calculus of Indirect Functions is necessarily divided into two parts; or rather, it is composed of two distinct calculi, having the relation of converse action. By the one we seek the relations between the auxiliary magnitudes, by means of the relations between the corresponding primitive magnitudes; by the other we seek, conversely, these direct equations by means of the indirect equations first established. This is the double object of the transcendental analysis.

Different names have been given to the two systems, according to the point of view from which the entire analysis has been regarded. The infinitesimal method, properly so called, being most in use, almost all geometers employ the terms *Differential Calculus* and *Integral Calculus* established by Leibnitz. Newton, in accordance with his method, called the first the *Calculus of Fluxions*, and the second the *Calculus af Fluents*, terms which were till lately commonly adopted in England. According to the theory of Lagrange, the one would be called the *Calculus of Derived Functions*, and the other the *Calculus of Primitive Functions.* I shall make use of the terms of Leibnitz, as the fittest for the formation of secondary expressions, though we must, as has been shown, employ all the conceptions concurrently, approaching as nearly as may be to that of Lagrange.

Their mutual relations.

The differential calculus is obviously the rational basis of the integral. We have seen that ten simple functions constitute the elements of our analysis. We cannot know how to integrate directly any other differential expressions than those produced by the differentiation of those ten functions. The art of integration consists therefore in bringing all the other cases, as far as possible, to depend wholly on this small number of simple functions.

It may not be apparent to all minds what can be the proper utility of the differential calculus, independently of this necessary connection with the integral calculus, which seems as if it must be in itself the only directly indispensable one; in fact, the elimination of the *infinitesimals* or the *derivatives*, introduced as auxiliaries, being the final object of the calculus of indirect functions, it is natural to think that the calculus which teaches us to deduce the equations between the primitive magnitudes from those between the auxiliary magnitudes must meet all the general needs of the trans cendental analysis, without our seeing at first what special and constant part the solution of the inverse question can have in such an analysis. A common answer is assigning to the differential calculus the office of forming the differential equations; but this is clearly an error; for the primitive formation of differential equations is not the business of any calculus, for it is, on the contrary, the point of departure of any calculus whatever. The very use of the differential calculus is enabling us to *differentiate* the various equations; and it cannot therefore be the process for establishing them. This common error arises from confounding the infinitesimal *calculus* with the infinitesimal *method*, which last facilitates the formation of equations, in every application of the transcendental analysis. The calculus is the indispensable complement of the method; but it is perfectly distinct from it. But again, we should much misconceive the peculiar importance of this first branch of the calculus of indirect functions if we saw in it only a preliminary process, designed merely to prepare an indispensable basis for the integral calculus. A few words will show that a primary direct and necessary office is always assigned to the differential calculus.

Cases of union of the two.

In forming differential equations, we rarely restrict ourselves to introducing differentially only those magnitudes whose relations are sought. It would often be impossible to establish equations without introducing other magnitudes whose relations are, or are supposed to be, known. Now in such cases it is necessary that the differentials of these intermediaries should be eliminated before the equations are fit for integration. This elimination belongs to the differential calculus; for it must be done by determining, by means of the equations between the intermediary functions, the relations of their differentials; and this is merely a question of differentiation. This is the way in which the differential calculus not only prepares a basis for the integral, but makes it available in a multitude of cases which could not otherwise be treated.

Cases of the Differential calculus alone.

There are some questions, few, but highly important, which admit of the employment of the differential calculus alone. They are those in which the magnitudes sought enter directly, and not by their differentials, into the primitive differential equations, which then contain differentially only the various known functions employed, as we saw just now, as intermediaries. This calculus is here entirely sufficient for the elimination of the infinitesimals, without the question giving rise to any integration.

Cases of the Integral calculus alone.

There are also questions, few, but highly important, which are the converse of the last, requiring the employment of the integral calculus alone. In these, the differential equations are found to be immediately ready for integration, because they contain, at their first formation, only the infinitesimals which relate to the functions sought, or to the really independent variables, without the introduction, differentially, of any intermediaries being required. If intermediary functions are introduced, they will, by the hypothesis, enter directly, and not by their differentials; and then, ordinary algebra will serve for their elimination, and to bring the question to depend on the integral calculus only. The differential calculus is, in such cases, not essential to the solution of the problem, which will depend entirely on the integral calculus. Thus, all questions to which the analysis is applicable are contained in three classes. The first class comprehends the problems which may be resolved by the differential calculus alone. The second, those which may be resolved by the integral calculus alone. These are only exceptional; the third constituting the normal case; that in which the differential and integral calculus have each a distinct and necessary part in the solution of problems.

The Differential Calculus.

The entire system of the differential calculus is simple and perfect, while the integral calculus remains extremely imperfect.

The Differential Calculus.

We have nothing to do here with the applications of either calculus, which are quite a different study from that of the abstract principles of differentiation and integration. The consequence of the common practice of confounding these principles with their application, especially in geometry, is that it becomes difficult to conceive of either analysis or geometry. It is in the department of Concrete Mathematics that the application should be studied.

Two portions.

The first division of the differential calculus is grounded on the condition whether the functions to be differentiated are *explicit* or *implicit*; the one giving rise to the differentiation of *formulas*, and the other to the differentiation of *equations*. This classification is rendered necessary by the imperfection of ordinary analysis; for if we knew how to resolve all equations algebraically, it would be possible to render every implicit function explicit; and, by differentiating it only in that state, the second part of the differential calculus would be immediately included in the first, without giving rise to any new difficulty. But the algebraic resolution of equations is, as we know, still scarcely past its infancy, and unknown for the greater number of cases; and we have to differentiate a function without knowing it, though it is determinate. Thus we have two classes of questions, the differentiation of implicit functions being a distinct case from that of explicit functions, and much more complicated. We have to begin by the differentiation of formulas, and we may then refer to this first case the differentiation of equations, by certain analytical considerations which we are not concerned with here. There is another view in which the two general cases of differentiation are distinct. The relation obtained between the differentials is always more indirect, in comparison with that of the finite quantities, in the differentiation of implicit, than in that of explicit functions. We shall meet with this consideration in the case of the integral calculus, where it acquires a preponderant importance.

Subdivisions.

Each of these parts of the differential calculus is again divided: and this subdivision exhibits two very distinct theories, according as we have to differentiate functions of a single variable, or functions of several independent variables,—the second branch being of far greater complexity than the first, in the case of explicit functions, and much more in that of implicit. One more distinction remains, to complete this brief sketch of the parts of the differential calculus. The case in which it is required to differentiate at once different implicit functions *combined* in certain primitive equations must be distinguished from that in which all these functions are *separate*. The same imperfection of ordinary analysis which prevents our converting every implicit function into an equivalent explicit one, renders us unable to separate the functions which enter simultaneously into any system of equations; and the functions are evidently still more implicit in the case of combined than of separate functions: and in differentiating, we are not only unable to resolve the primitive equations, but even to effect the proper elimination among them.

Reduction to the elements.

We have now seen the different parts of this calculus in their natural connection and rational distribution. The whole calculus is finally found to rest upon the differentiation of explicit functions with a single variable,—the only one which is ever executed directly. Now, it is easy to understand that this first theory, this necessary basis of the whole system, simply consists of the differentiation of the elementary functions, ten in number, which compose all our analytical combinations; for the differentiation of compound functions is evidently deduced, immediately and necessarily, from that of their constituent simple functions. We find, then, the whole system of differentiation reduced to the knowledge of the ten fundamental differentials, and to that of the two general principles, by one of which the differentiation of implicit functions is deduced from that of explicit, and by the other, the differentiation of functions of several variables is reduced to that of functions of a single variable. Such is the simplicity and perfection of the system of the differential calculus.

Transformation of derived functions for new variables.

The *transformations of derived Functions for new variables* is a theory which must be just mentioned, to avoid the omission of an indispensable complement of the system of differentiation. It is as finished and perfect as the other parts of this calculus; and its great importance is in its increasing our resources by permitting us to choose, to facilitate the formation of differential equations, that system of independent variables which may appear to be most advantageous, though it may afterward be relinquished, as an intermediate step, by which, through this theory, we may pass to the final system, which sometimes could not have been considered directly.

Analytical applications.

Though we can not here consider the concrete applications of this calculus, we must glance at those which are analytical, because they are of the same nature with the theory, and should be looked at in connection with it. These questions are reducible to three essential ones. First, the development into series of functions of one or more variables; or, more generally, the transformation of functions, which constitutes the most beautiful and the most important application of the differential calculus to general analysis, and which comprises, besides the fundamental series discovered by Taylor, the remarkable series discovered by Maclaurin, John Bernouilli, Lagrange and others. Secondly, the general theory of *maxima* and *minima* values for any functions whatever of one or more variables; one of the most interesting problems that analysis can present, however elementary it has become. The third is the least important of the three:—it is the determination of the true value of functions which present themselves under an indeterminate appearance, for certain hypotheses made on the values of the corresponding variables. In every view, the first question is the most eminent; it is also the most susceptible of future extension, especially by conceiving, in a larger manner than hitherto, of the employment of the differential calculus for the transformation of functions, about which Lagrange left some valuable suggestions which have been neither generalized nor followed up.

It is with regret that I confine myself to the generalities which are the proper subjects of this work; so extensive and so interesting are the developments which might otherwise be offered. Insufficient and summary as are the views of the Differential Calculus just offered, we must be no less rapid in our survey of the Integral Calculus, properly so called; that is, the abstract subject of integration.

The Integral Calculus.

The Integral Calculus.

Its divisions.

The division of the Integral Calculus, like that of the Differential, proceeds on the principle of distinguishing the integration of *explicit* differential formulas from the integration of *implicit* differentials, or of differential equations. The separation of these two cases is even more radical in the case of integration than in the other. In the differential calculus this distinction rests, as we have seen, only on the extreme imperfection of ordinary analysis. But, on the other hand, it is clear that even if all equations could be algebraically resolved, differential equations would nevertheless constitute a case of integration altogether distinct from that presented by explicit differential formulas. Their integration is necessarily more complicated than that of explicit differentials, by the elaboration of which the integral calculus was originated, and on which the others have been made to depend, as far as possible. All the various analytical processes hitherto proposed for the integration of differential equations, whether by the separation of variables, or the method of multipliers, or other means, have been designed to reduce these integrations to those of differential formulas, the only object which can be directly undertaken. Unhappily, imperfect as is this necessary basis of the whole integral calculus, the art of reducing to it the integration of differential equations is even much less advanced.

Subdivisions.

One variable, or several.

As in the case of the differential calculus, and for analogous reasons, each of these two branches of the integral calculus is divided again, according as we consider functions with a single variable or functions with several independent variables. This distinction is, like the preceding, even more important for integration than for differentiation. This is especially remarkable with respect to differential equations. In fact, those which relate to several independent variables may evidently present this characteristic and higher difficulty—that the function sought may be differentially defined by a simple relation between its various special derivatives with regard to the different variables taken separately. Thence results the most difficult, and also the most extended branch of the integral calculus, which is commonly called the Integral Calculus of partial differences, created by D'Alembert, in which, as Lagrange truly perceived, geometers should have recognised a new calculus, the philosophical character of which has not yet been precisely decided. This higher branch of transcendental analysis is still entirely in its infancy. In the very simplest case, we can not completely reduce the integration to that of the ordinary differential equations.

Orders of differentiation.

A new distinction, highly important here, though not in the differential calculus, where it is a mistake to insist upon it, is drawn from the higher or lower order of the differentials. We may regard this distinction as a subdivision in the integration of explicit or implicit differentials. With regard to explicit differentials, whether of one variable or of several, the necessity of distinguishing their different orders is occasioned merely by the extreme imperfection of the integral calculus; and, with reference to implicit differentials, the distinction of orders is more important still. In the first case, we know so little of integration of even the first order of differential formulas, that differential formulas of a high order produce new difficulties in arriving at the primitive function which is our object. And in the second case, there is the additional difficulty that the higher order of the differential equations necessarily gives rise to questions of a new kind. The higher the order of differential equations, the more implicit are the cases which they present; and they can be made to depend on each other only by special methods, the investigation of which, in consequence, forms a new class of questions with regard to the simplest cases of which we as yet know next to nothing.

The necessary basis of all other integrations is, as we see from the foregoing considerations, that of explicit differential formulas of the first order and of a single variable; and we can not succeed in effecting other integrations but by reducing them to this elementary case, which is the only one capable of being treated

Quadratures.

directly. This simple fundamental integration, often conveniently called *quadratures*, corresponds in the differential calculus to the elementary case of the differentiation of explicit functions of a single variable. But the integral question is, by its nature, quite otherwise complicated, and much more extensive than the differential question. We have seen that the latter is reduced to the differentiation of ten simple functions, which furnish the elements of analysis; but the integration of compound functions does not necessarily follow from that of the simple functions, each combination of which may present special difficulties with respect to the integral calculus. Hence the indefinite extent and varied complication of the question of quadratures, of which we know scarcely anything completely, after all the efforts of analysts.

Algebraic functions.

The question is divided into the two cases of *algebraic functions* and *transcendental functions*. The algebraic class is the more advanced of the two. In relation to irrational functions, it is true, we know scarcely anything, the integrals of them having been obtained only in very restricted cases, and particularly by rendering them rational. The integration of rational functions is thus far the only theory of this calculus which has admitted of complete treatment; and thus it forms, in a logical point of view, its most satisfactory part, though it is perhaps the least important. Even here, the imperfection of ordinary analysis usually comes in to stop the working of the theory, by which the integration finally depends on the algebraic solution of equations; and thus it is only in what concerns integration viewed in an abstract manner that even this limited case is resolved. And this gives us an idea of the extreme imperfection of the integral calculus. The case of the integration of transcendental functions is quite in its infancy as yet, as regards either exponential, logarithmic, or circular functions. Very few cases of these kinds have been treated; and though the simplest have been chosen, the necessary calculations are extremely laborious.

Transcendental functions.

Singular solutions.

The theory of *Singular Solutions* (sometimes called Particular Solutions), fully developed by Lagrange in his Calculus of Functions, but not yet duly appreciated by geometers, must be noticed here, on account of its logical perfection and the extent of its applications. This theory forms implicitly a portion of the general theory of the integration of differential equations; but I have left it till now, because it is, as it were, outside of the integral calculus, and I wished to preserve the sequence of its parts. Clairaut first observed the existence of these solutions, and he saw in them a paradox of the integral calculus, since they have the property of satisfying the differential equations without being comprehended in the corresponding general integrals. Lagrange explained this paradox by showing how such solutions are always derived from the general integral by the variation of the arbitrary constants. This theory has a character of perfect generality; for Lagrange has given invariable and very simple processes for finding the singular solution of any differential equation which admits of it; and, what is very remarkable, these processes require no integration, consisting only of differentiations, and being therefore always applicable. Thus has differentiation become, by a happy artifice, a means of compensating, in certain circumstances, for the imperfection of the integral calculus.

Definite integrals.

One more theory remains to be noticed, to complete our review of that collection of analytical researches which constitutes the integral calculus. It takes its place outside of the system, because, instead of being destined for true integration, it proposes to supply the defect of our ignorance of really analytical integrals. I refer to the determination of *definite integrals.* These definite integrals are the values of the required functions for certain determinate values of the corresponding variables. The use of these in transcendental analysis corresponds to the numerical resolution of equations in ordinary analysis. Analysts being usually unable to obtain the real integral (called in opposition the *general* or *indefinite* integral), that is, the function which, differentiated, has produced the proposed differential formula, have been driven to determining, at least, without knowing this function, the particular numerical values which it would take on assigning certain declared values to the variables. This is evidently resolving the arithmetical question without having first resolved the corresponding algebraic one, which is generally the most important; and such an analysis is, by its nature, as imperfect as that of the numerical resolution of equations. Inconveniences, logical and practical, result from such a confusion of arithmetical and algebraic considerations. But, under our inability to obtain the true integrals, it is of the utmost importance to have been able to obtain this solution, incomplete and insufficient as it is. This has now been attained for all cases, the determination of the value of definite integrals having been reduced to entirely general methods, which leave nothing to be desired, in many cases, but less complexity in the calculations; an object to which analysts are now directing all their special transformations. This kind of *transcendental arithmetic* being considered perfect, the difficulty in its applications is reduced to making the proposed inquiry finally depend only on a simple determination of definite integrals; a thing which evidently can not be always possible, whatever analytical skill may be employed in effecting so forced a transformation.

Prospects of the Integral Calculus.

We have now seen that while the differential calculus constitutes by its nature a limited and perfect system, the integral calculus, or the simple subject of integration, offers inexhaustible scope for the activity of the human mind, independently of the indefinite applications of which transcendental analysis is evidently capable. The reasons which convince us of the impossibility of ever achieving the general resolution of algebraic equations of any degree whatever, are yet more decisive against our attainment of a single method of integration applicable to all cases. "It is," said Lagrange, "one of those problems whose general solution we can not hope for." The more we meditate on the subject, the more convinced we shall be that such a research is wholly chimerical, as transcending the scope of our understanding, though the labors of geometers must certainly add in time to our knowledge of integration, and create procedures of a wider generality. The transcendental analysis is yet too near its origin, it has too recently been regarded in a truly rational manner, for us to have any idea what it may hereafter become. But, whatever may be our legitimate hopes, we must ever, in the first place, consider the limits imposed by our intellectual constitution, which are not the less real because we can not precisely assign them.

I have hinted that a future augmentation of our resources may probably arise from a change in the mode of derivation of the auxiliary quantities introduced to facilitate the establishment of equations. Their formation might follow a multitude of other laws besides the very simple relation which has been selected. I discern here far greater resources than in urging further our present calculus of indirect functions; and I am persuaded that when geometers have exhausted the most important applications of our present transcendental analysis, they will turn their attention in this direction, instead of straining after perfection where it can not be found. I submit this view to geometers whose meditations are fixed on the general philosophy of analysis.

As for the rest, though I was bound to exhibit in my summary exposition the state of extreme imperfection in which the integral calculus still remains, it would be entertaining a false idea of the general resources of the transcendental analysis to attach too much importance to this consideration. As in ordinary analysis, we find here that a very small amount of fundamental knowledge respecting the resolution of equations is of inestimable use. However little advanced geometers are as yet in the science of integrations, they have nevertheless derived from their few abstract notions the solution of a multitude of questions of the highest importance in geometry, mechanics, thermology, etc. The philosophical explanation of this double general fact is found in the preponderating importance and scope of abstract science, the smallest portion of which naturally corresponds to a multitude of concrete researches, Man having no other resource for the successive extension of his intellectual means than in the contemplation of ideas more and more abstract, and nevertheless positive.

Calculus of Variations.

By his *Calculus* or *Method of Variations*, Lagrange improved the capacity of the transcendental analysis for the establishment of equations in the most difficult problems, by considering a class of equations still more *indirect* than differential equations properly so called. It is still too near its origin, and its applications have been too few, to admit of its being understood by a purely abstract account of its theory; and it is therefore necessary to indicate briefly the special nature of the problems which have given rise to this hyper-transcendental analysis.

Problems giving rise to this Calculus.

These problems are those which were long known by the name of *Isoperimetrical Problems;* a name which is truly applicable to only a very small number of them. They consist in the investigation of the *maxima* and *minima* of certain indeterminate integral formulas which express the analytical law of such or such a geometrical or mechanical phenomenon, considered independently of any particular subject.

In the ordinary theory of *maxima* and *minima*, we seek, with regard to a given function of one or more variables, what particular values must be assigned to these variables, in order that the corresponding value of the proposed function may be a maximum or a minimum with respect to those values which immediately precede and follow it:—that is, we inquire, properly speaking, at what instant the function ceases to increase in order to begin to decrease, or the reverse. The differential calculus fully suffices, as we know, for the general resolution of this class of questions, by showing that the values of the different variables which suit either the maximum or minimum must always render null the different derivatives of the first order of the given function, taken separately with relation to each independent variable; and by indicating moreover a character suitable for distinguishing the maximum from the minimum, which consists, in the case of a function of a single variable, for example, in the derived function of the second order taking a negative value for the maximum and a positive for the minimum. Such are the fundamental conditions belonging to the majority of cases; and where modifications take place, they are equally subject to invariable, though more complicated abstract rules.

The construction of this general theory having destroyed the chief interest of geometers in this kind of questions, they rose almost immediately to the consideration of a new order of problems, at once more important and more difficult,—those of *isoperimeters.* It was then no longer the values of the variables proper to the maximum or the minimum of a given function that had to be determined. It was the form of the function itself that had to be discovered, according to the condition of the maximum or minimum of a certain definite integral, merely indicated, which depended on that function. We can not here follow the history of these problems, the oldest of which is that of *the solid of least resistance*, treated by Newton in the second book of the "Principia," in which he determines what must be the meridian curve of a solid of revolution, in order that the resistance experienced by that body in the direction of its axis may be the least possible. Mechanics first furnished this new class of problems; but it was from geometry that the subjects of the principal investigations were afterward derived. They were varied and complicated almost infinitely by the labors of the best geometers, when Lagrange reduced their solution to an abstract and entirely general method, the discovery of which has checked the eagerness of geometers about such an order of researches.

It is evident that these problems, considered analytically, consist in determining what ought to be the form of a certain unknown function of one or more variables, in order that such or such an integral, dependent on that function, may have, within assigned limits, a value which may be a maximum or a minimum, with regard to all those which it would take if the required function had any other form whatever. In treating these problems, the predecessors of Lagrange proposed, in substance, to reduce them to the ordinary theory of maxima and minima. But they proceeded by applying special simple artifices to each case, not reducible to certain rules, so that every new question reproduced analogous difficulties, without the solutions previously obtained being of any essential aid. The part common to all questions of this class had not been discovered; and no abstract and general treatment was therefore provided. In his endeavors to bring all isoperimetrical problems to depend on a common analysis, Lagrange was led to the conception of a new kind of differentiation; and to these new Differentials he gave the name of Variations. They consist of the infinitely small increments which the integrals receive, not in virtue of analogous increments on the part of the corresponding variables, as in the common transcendental analysis, but by supposing that the *form* of the function placed under the sign of integration undergoes an infinitely small change. This abstract conception once formed, Lagrange was able to reduce with ease, and in the most general manner, all the problems of isoperimeters to the simple common theory of maxima and minima.

Other applications.

Important as is this great and happy transformation, and though the Method of Variations had at first no other object than the rational and general resolution of isoperimetrical problems, we should form a very inadequate estimate of this beautiful analysis if we supposed it restricted to this application. In fact, the abstract conception of two distinct natures of differentiation is evidently applicable, not only to the cases for which it was created, but for all which present, for any reason whatever, two different ways of making the same magnitudes vary. Lagrange himself made an immense and all-important application of his Calculus of Variations, in his 'Analytical Mechanics,' by employing it to distinguish the two sorts of changes, naturally presented by questions of rational Mechanics for the different points we have to consider, according as we compare the successive positions occupied, in virtue of its motion, by the same point of each body in two consecutive instants, or as we pass from one point of the body to another in the same instant. One of these comparisons produces the common differentials; the other occasions variations which are, there as elsewhere, only differentials taken from a new point of view. It is in such a general acceptation as this that we must conceive of the Calculus of Variations, to appreciate fitly the importance of this admirable logical instrument; the most powerful as yet constructed by the human mind.

This Method being only an immense extension of the general transcendental analysis, there is no need of proof that it admits of being considered under the different primary points of view allowed by the calculus of indirect functions, as a whole. Lagrange invented the calculus of variations in accordance with the infinitesimal conception, properly so called, and even some time before he undertook the general reconstruction of the transcendental analysis. When he had effected that important reform, he easily showed how applicable it was to the calculus of variations, which he exhibited with all suitable development, according to his theory of derived functions. But the more difficult in the use the method of variations is found to be, on account of the higher degree of abstraction of the ideas considered, the more important it is to husband the powers of our minds in its application, by adopting the most direct and rapid analytical conception, which is, as we know, that of Leibnitz. Lagrange himself, therefore, constantly preferred it in the important use which he made of the calculus of variations in his "Analytical Mechanics." There is not, in fact, the slightest hesitation about this among geometers.

Relation to the ordinary Calculus.

In the section on the Integral Calculus, I noticed D'Alembert's creation of the *Calculus of partial differences*, in which Lagrange recognised a new calculus. This new elementary idea in transcendental analysis,—the notion of two kinds of increments, distinct and independent of each other, which a function of two variables may receive in virtue of the change of each variable separately,—seems to me to establish a natural and necessary transition between the common infinitesimal calculus and the calculus of variations. D'Alembert's view appears to me to approximate, by its nature, very nearly to that which serves as a general basis for the Method of Variations. This last has, in fact, done nothing more than transfer to the independent variables themselves the view already adopted for the functions of those variables; a process which has remarkably extended its use. A recognition of such a derivation as this for the method of variations may exhibit its philosophical character more clearly and simply; and this is my reason for the reference.

The Method of Variations presents itself to us as the highest degree of perfection which the analysis of indirect functions has yet attained. We had before, in that analysis, a powerful instrument for the mathematical study of natural phenomena, inasmuch as it introduced the consideration of auxiliary magnitudes, so chosen as that their relations were necessarily more simple and easy to obtain than those of the direct magnitudes. But we had not any general and abstract rules for the formation of these differential equations; nor were such supposed to be possible. Now, the Analysis of Variations brings the actual establishment of the differential equations within the reach of the Calculus; for such is the general effect, in a great number of important and difficult questions, of the *varied* equations, which, still more *indirect* than the simple differential equations, as regards the special objects of the inquiry, are more easy to form: and, by invariable and complete analytical methods, employed to eliminate the new order of auxiliary infinitesimals introduced, we may deduce those ordinary differential equations which we might not have been able to establish directly. The Method of Variations forms, then, the most sublime part of that vast system of mathematical analysis, which, setting out from the simplest elements of algebra, organizes, by an uninterrupted succession of ideas, general methods more and more potent for the investigation of natural philosophy. This is incomparably the noblest and most unquestionable testimony to the scope of the human intellect. If, at the same time, we bear in mind that the employment of this method exacts the highest known degree of intellectual exertion, in order never to lose sight of the precise object of the investigation in following reasonings which offer to the mind such uncertain resting-places, and in which signs are of scarcely any assistance, we shall understand how it may be that so little use has been made of such a conception by any philosophers but Lagrange.

We have now reviewed Mathematical analysis, in its bases and in its divisions, very briefly, but from a philosophical point of view, neglecting those conceptions only which are not organized with the great whole, or which, if urged to their limit, would be found to merge in some which have been examined. I must next offer a similar outline of Concrete Mathematics. My particular task will be to show how, supposing the general science of the Calculus to be in a perfect state,—it has been possible to reduce, by invariable procedures, to pure questions of analysis, all the problems of GEOMETRY and MECHANICS; and thus to invest these two great bases of natural philosophy with that precision and unity which can only thus be attained, and which constitute high perfection

CHAPTER III.

GENERAL VIEW OF GEOMETRY.

Its nature.

We have seen that GEOMETRY is a true natural science;—only more simple, and therefore more perfect, than any other. We must not suppose that, because it admits the application of mathematical analysis, it is therefore a purely logical science, independent of observation. Every body studied by geometers presents some primitive phenomena which, not being discoverable by reasoning, must be due to observation alone.

The scientific eminence of Geometry arises from the extreme generality and simplicity of its phenomena. If all the parts of the universe were regarded as immovable, geometry would still exist; whereas, for the phenomena of Mechanics, motion is required. Thus Geometry is the more general of the two. It is also the more simple, for its phenomena are independent of those of Mechanics, while mechanical phenomena are always complicated with those of geometry. The same is true in the comparison of abstract thermology with geometry. For these reasons, geometry holds the first place under the head of Concrete Mathematics.

Definition.

Instead of adopting the inadequate ordinary account of Geometry, that it is the *science of extension*, I am disposed to give as a general description of it, that it is the science of the *measurement of extension*. Even this does not include all the operations of geometry, for there are many investigations which do not appear to have for their object the measurement of extension. But regarding the science in its leading questions as a whole, we may accurately say that the measurement of lines, of surfaces, and of volumes, is the invariable aim—sometimes direct, though oftener indirect—of geometrical labors.

Idea of Space.

The rational study of geometry could never have begun if we must have regarded at once and together all the physical properties of bodies, together with their magnitude and form. By the character of our minds we are able to think of the dimensions and figure of a body in an abstract way. After observation has shown us, for instance, the impression left by a body on a fluid in which it has been placed, we are able to retain an image of the impression, which becomes a ground of geometrical reasoning. We thus obtain, apart from all metaphysical fancies, an idea of Space. This abstraction, now so familiar to us that we can not perceive the state we should be in without it, is perhaps the earliest philosophical creation of the human mind.

Kinds of extension.

There is another abstraction which must be made before we can enter on geometrical science. We must conceive of three kinds of extension, and learn to conceive of them separately. We can not conceive of any space, filled by any object, which has not at once *volume*, *surface*, and *line*. Yet geometrical questions often relate to only two of these; frequently only to one. Even when all three are to be finally considered, it is often necessary, in order to avoid complication, to take only one at a time. This is the second abstraction which it is indispensable for us to practise—to think of surface and line apart from volume; and again, of line apart from surface. We effect this by thinking of volume as becoming thinner and thinner, till surface appears as the thinnest possible layer or film: and again, we think of this surface becoming narrower and narrower till it is reduced to the finest imaginable thread; and then we have the idea of a line. Though we can not speak of a point as a dimension, we must have the abstract idea of that too; and it is obtained by reducing the line from one end or both, till the smallest conceivable portion of it is left. This point indicates, not extension of course, but position, or the place of extension. Surfaces have clearly the property of circumscribing volumes; lines, again, circumscribe surfaces; and lines, once more, are limited by points.

Geometrical measurement.

The Mathematical meaning of *measurement* is simply the finding the value of the *ratios* between any homogeneous magnitudes: but geometrically, the measurement is always indirect. The comparison of two lines is direct; that of two surfaces or two volumes can never be direct. One line may be conceived to be laid upon another: but one volume can not be conceived of as laid upon another, nor one surface upon another, with any convenience or exactness. The question is, then, how to measure surfaces and volumes.

Measurement of surfaces and volumes.

Whatever be the form of a body, there must always be lines, the length of which will define the magnitude of the surface or volume. It is the business of geometry to use these lines, directly measurable as they are, for the ascertainment of the *ratio* of the surface to the unity of surface, or of the volume to the unity of volume, as either may be sought. In brief, the object is to reduce all comparisons of surfaces or of volumes to simple comparison of lines. Extending the process, we find the possibility of reducing to questions of lines all questions relating to surfaces and volumes, regarded in relation to their magnitude. It is true that when the rational method becomes too complicated and difficult, direct comparisons of surfaces and volumes are employed: but the procedure is not geometrical. In the same way, the consideration of weight is sometimes brought in, to determine volume, or even surface; but this device is derived from mechanics, and has nothing to do with rational geometry.

Of curved lines.

In speaking of the direct measurement of lines, it is clear that right lines are meant. When we consider curve lines, it is evident that their measurement must be indirect, since we can not conceive of curved lines being laid upon each other with any precision or certainty. The procedure is first to reduce the measurement of curved to that of right lines; and consequently to reduce to simple questions of right lines all questions relating to the magnitude of any curves whatever. In every curve, there always exist certain right lines, the length of which must determine that of the curve; as the length of the radius of a circle gives us that of the circumference; and again, as the length of an ellipse depends on that of its two axes.

Thus, the science of Geometry has for its object the final reduction of the comparisons of all kinds of extent to comparisons of right lines, which alone are capable of direct comparison, and are, moreover, eminently easy to manage.

I must just notice that there is a primary distinct branch of Geometry, exclusively devoted to the right line, on account of occasional insurmountable difficulties in making the direct comparison; its object is to determine certain right lines from others by means of the relations proper to the figures resulting from their assemblage. The importance of this is clear, as no question could be solved if the measurement of right lines, on which every other depends, were left, in any case, uncertain. The natural order of the parts of rational geometry is therefore, first the geometry of *line*, beginning with the right line; then the geometry of *surfaces;* and, finally, that of *volumes.*

Its illimitable field.

The field of geometrical science is absolutely unbounded. There may be as many questions as there are conceivable figures; and the variety of conceivable figures is infinite. As to curved Lines, if we regard them as generated by the motion of a point governed by a certain law, we can not limit their number, as the variety of distinct conditions is nothing short of infinite; each generating new ones, and those again others. Surfaces again, are conceived of as motions of lines; and they not only partake of the variety of lines, but have another of their own, arising from the possible change of nature in the line. There can be nothing like this in lines, as points can not describe a figure. Thus, there is a double set of conditions under which the figures of surfaces may vary: and we may say that if lines have one infinity of possible change, surfaces have two. As for volumes, they are distinguished from one another only by the surfaces which bound them; so that they partake of the variety of surfaces, and need no special consideration under this head. If we add the one further remark, that surfaces themselves furnish a new means of conceiving of new curves, as every curve may be regarded as produced by the intersection of two surfaces, we shall perceive that, starting from a narrow ground of observation, we can obtain an absolutely infinite variety of forms, and therefore an illimitable field for geometrical science.

The connection between abstract and concrete geometry is estab-

Properties of lines and surfaces.

lished by the study of the *properties* of lines and surfaces. Without multiplying in this way our means of recognition, we should not know, except by accident, how to find in nature the figure we desire to verify. Astronomy was recreated by Kepler's discovery that the ellipse was the curve which the planets describe about the sun, and the satellites about their planet. This discovery could never have been made if geometers had known no more of the ellipse than as the oblique section of a circular cone by a plane. All the properties of the conic sections brought out by the speculative labors of the Greek geometers, were needed as preparation for this discovery, that Kepler might select from them the characteristic which was the true key to the planetary orbit. In the same way, the spherical figure of the earth could not have been discovered if the primitive character of the sphere had been the only one known;—viz., the equidistance of all its points from an interior point. Certain properties of surfaces were the means used for connecting the abstract reasoning with the concrete fact. And others, again, were required to prove that the earth is not absolutely spherical, and how much otherwise. The pursuit of these labors does not interfere with the definition of Geometry given above, as they tend indirectly to the measurement of extension. The great body of geometrical researches relates to the properties of lines and surfaces; and the study of the properties of the same figure is so extensive, that the labors of geometers for twenty centuries have not exhausted the study of conic sections. Since the time of Descartes, it has become less important; but it appears as far as ever from being finished. And here opens another infinity. We had before the infinite scope of lines, and the double infinity of surfaces: and now we see that not only is the variety of figures inexhaustible, but also the diversity of the points of view from which each figure may be regarded.

Two general Methods.

There are two general Methods of treating geometrical questions. These are commonly called Synthetical Geometry and Analytical Geometry. I shall prefer the historical titles of Geometry of the Ancients and Geometry of the Moderns. But it is, in my view, better still to call them Special Geometry and General Geometry, by which their nature is most accurately conveyed.

Special or ancient, and general or modern Geometry.

The Calculus was not, as some suppose, unknown to the ancients, as we perceive by their applications of the theory of proportions. The difference between them and us is not so much in the instrument of deduction as in the nature of the questions considered. The ancients studied geometry with reference to the *bodies* under notice, or specially; the moderns study it with reference to the *phenomena* to be considered, or generally. The ancients extracted all they could out of one line or surface, before passing to another; and each inquiry gave little or no assistance in the next. The moderns, since Descartes, employ themselves on questions which relate to any figure whatever. They abstract, to treat by itself, every question relating to the same geometrical phenomenon, in whatever bodies it may be considered Geometers can thus rise to the study of new geometrical conceptions, which, applied to the curves investigated by the ancients, have brought out new properties never suspected by them. The superiority of the modern method is obvious at a glance. The time formerly spent, and the sagacity and effort employed, in the path of detail, are inconceivably economized by the general method used since the great revolution under Descartes. The benefit to Concrete Geometry is no less than to the Abstract; for the recognition of geometrical figures in nature was merely embarrassed by the study of lines in detail; and the application of the contemplated figure to the existing body could be only accidental, and within a limited or doubtful range: whereas, by the general method, no existing figure can escape application to its true theory, as soon as its geometrical features are ascertained. Still, the ancient method was natural; and it was necessary that it should precede the modern. The experience of the ancients, and the materials they accumulated by their special method, were indispensable to suggest the conception of Descartes, and to furnish a basis for the general procedure. It is evident that the Calculus can not originate any science. Equations must exist as a starting-point for analytical operations. No other beginning can be made than the direct study of the object, pursued up to the point of the discovery of precise relations.

Geometry of the ancients. We must briefly survey the geometry of the ancients, in its character of an indispensable introduction to that of the moderns. The one, special and preliminary, must have its relation made clear to the other,—the general and definitive geometry, which now constitutes the science that goes by that name.

We have seen that Geometry is a science founded upon observation, though the materials furnished by observation are few and simple, and the structure of reasoning erected upon them vast and complex. The only elementary materials, obtainable by direct study alone, are those which relate to the right line for the geometry of *lines;* to the *quadrature* of rectilinear plane areas; and to the *cubature* of bodies terminated by plane faces. The beginning of geometry must be from the observation of lines, of flat surfaces angularly bounded, and of bodies which have more or less bulk, also angularly bounded. These are all; for all other figures, even the circle, and the figures belonging to it, now come under the head of analytical geometry. The three elements just mentioned allow a sufficiency of equations for the calculus to proceed upon. More are not needed; and we can not do with less. Some have endeavored to extend analysis so as to dispense with a portion of these facts: but to do so is merely to return to metaphysical practices, in presenting actual facts as logical abstractions. The more we perceive Geometry to be, in our day, essentially analytical, the more careful we must be not to lose sight of the basis of observation on which all geometrical science is founded. When we observe people attempting to demonstrate axioms and the like, we may avow that it is better to admit more than may be quite necessary of materials derived from observation, than to carry logical demonstration into a region where direct observation will serve us better.

Geometry of the right line.

There are two ways of studying the right line—the graphic and the algebraic. The thing to be done is to ascertain, by means of one another, the different elements of any right line whatever, so as to understand, indirectly, a right line, under any circumstances whatever. The way to do this is, first, to study the figure, by constructing it, or otherwise directly investigating it; and then, to reason from that observation. The ancients, in the early days of the science, made great use of the graphic method, even in the form of Construction; as when Aristarchus of Samos estimated the distance of the sun and moon from the earth on a triangle constructed as nearly as possible in resemblance to the rightangled triangle formed by the three bodies at the instant when the moon is in quadrature, and when therefore an observation of the angle at the earth would define the triangle. Archimedes himself, though he was the first to introduce calculated determinations into geometry, frequently used the same means. The introduction of trigonometry lessened the practice; but did not abolish it. The Greeks and Arabians employed it still for a great number of investigations for which we now consider the use of the Calculus indispensable.

Graphical solutions.

While the graphic or constructive method answers well when all the parts of the proposed figure lie in the same plane, it must receive additions before it can be applied to figures whose parts lie in different planes. Hence arises a new series of considerations, and different systems of *Projections*. Where we now employ spherical trigonometry, especially for problems relating to the celestial sphere, the ancients had to consider how they could replace constructions in relief by plane constructions. This was the object of their *analemmas*, and of the other plane figures which long supplied the place of the Calculus. They were acquainted with the elements of what we call Descriptive Geometry, though they did not conceive of it in a distinct and general manner.

Descriptive Geometry.

Digressing here for a moment into the region of application, I may observe that Descriptive Geometry, formed into a distinct system by Monge, practically meets the difficulty just stated, but does not warrant the expectations of its first admirers, that it would enlarge the domain of rational geometry. Its grand use is in its application to the industrial arts;—its few abstract problems, capable of invariable solution, relating essentially to the contacts and intersections of surfaces; so that all the geometrical questions which may arise in any of the various arts of construction,—as stone-cutting, carpentry, perspective, dialling, fortification, etc.,—can always be treated as simple individual cases of a single theory, the solution being certainly obtainable through the particular circumstances of each case. This creation must be very important in the eyes of philosophers who think that all human achievement, thus far, is only a first step toward a philosophical renovation of the labors of mankind; toward that precision and logical character which can alone insure the future progression of all arts. Such a revolution must inevitably begin with that class of arts which bears a relation to the simplest, the most perfect, and the most ancient of the sciences. It must extend, in time, though less readily, to all other industrial operations. Monge, who understood the philosophy of the arts better than any one else, himself indeed endeavored to sketch out a philosophical system of mechanical arts, and at least succeeded in pointing out the direction in which the object must be pursued. Of Descriptive Geometry, it may further be said that it usefully exercises the students' faculty of Imagination,—of conceiving of complicated geometrical combinations in space; and that, while it belongs to the geometry of the ancients by the character of its solutions, it approaches to the geometry of the moderns by the nature of the questions which compose it. Consisting, as we have said, of a few abstract problems, obtained through Projections, and relating to the contacts and intersections of surfaces, the invariable solutions of these problems are at once graphical, like those of the ancients, and general, like those of the moderns. Yet, as destined to an industrial application, Descriptive Geometry has here been treated of only in the way of digression. Leaving the subject of *graphic* solution, we have to notice the other branch,—the *algebraic*.

Algebraic solutions.

Some may wonder that this branch is not treated as belonging to General Geometry. But not only were the ancients, in fact, the inventors of trigonometry,—spherical as well as rectilinear,—though it necessarily remained imperfect in their hands; but algebraic solutions are also no part of analytical geometry, but only a complement of elementary geometry.

Since all right-lined figures can be decomposed into triangles, all that we want is to be able to determine the different elements of a triangle by means of one another. This reduces polygonometry to simple trigonometry.

Trigonometry.

The difficulty lies in forming three distinct equations between the angles and the sides of a triangle. These equations being obtained, all trigonometrical problems are reduced to mere questions of analysis.—There are two methods of introducing the angles into the calculation. They are either introduced *directly*, by themselves or by the circular arcs which are proportional to them: or they are introduced *indirectly*, by the chords of these arcs, which are hence called their *trigonometrical lines*. The second of these methods was the first adopted, because the early state of knowledge admitted of its working, while it did not admit the establishment of equations between the sides of the triangles and the angles themselves, but only between the sides and the trigonometrical lines.—The method which employs the trigonometrical lines is till preferred, as the more simple, the equations existing only between right lines, instead of between right lines and arcs of circles.

To meet the probable objection that it is rather a complication than a simplification to introduce these lines, which have at least to be eliminated, we must explain a little.

Their introduction divides trigonometry into two parts. In one, we pass from the angles to their trigonometrical lines, or the con verse: in the other we have to determine the sides of the triangles by the trigonometrical lines of their angles, or the converse. Now, the first process is done for us, once for all, by the formation of numerical tables, capable of use in all conceivable questions. It is only the second, which is by far the least laborious, that has to be undertaken in each individual case. The first is always done in advance. The process may be compared with the theory of logarithms, by which all imaginable arithmetical operations are decomposed into two parts—the first and most difficult of which is done in advance.

We must remember, too, in considering the position of the ancients, the remarkable fact that the determination of angles by their trigonometrical lines, and the converse, admits of an arithmetical solution, without the previous resolution of the corresponding algebraic question. But for this, the ancients could not have obtained trigonometry. When Archimedes was at work upon the rectification of the circle, tables of chords were prepared: from his labors resulted the determination of a certain series of chords: and, when Hipparchus afterward invented trigonometry, he had only to complete that operation by suitable intercalations. The connection of ideas is here easily recognised.

For the same reasons which lead us to the employment of these lines, we must employ several at once, instead of confining ourselves to one, as the ancients did. The Arabians, and after them the moderns, attained to only four or five direct trigonometrical lines altogether; whereas it is clear that the number is not limited. Instead, however, of plunging into deep complications, in obtaining new direct lines, we create indirect ones. Instead, for instance, of directly and necessarily determining the sine of an angle, we may determine the sine of its half, or of its double,—taking any line relating to an arc which is a very simple function of the first. Thus, we may say that the number of trigonometrical lines actually employed by modern geometers is unlimited through the augmentations we may obtain by analysis. Special names have, however, been given to those indirect lines only which refer to the complement of the primitive arc—others being in much less frequent use.

Out of this device arises a third section of trigonometrical knowledge. Having introduced a new set of lines—of auxiliary magni tudes—we have to determine their relation to the first. And this study, though preparatory, is indefinite in its scope, while the two other departments are strictly limited.

The three must, of course, be studied in just the reverse order to that in which it has been necessary to exhibit them. First, the student must know the relations between the indirect and direct trigonometrical lines: and the resolution of triangles, properly so called, is the last process.

Spherical trigonometry requires no special notice here (all-important as it is by its uses)—since it is, in our day, simply an application of rectilinear trigonometry, through the substitution of the corresponding trihedral angle for the spherical triangle.

This view of the philosophy of trigonometry has been given chiefly to show how the most simple questions of elementary geometry exhibit a close dependence and regular ramification.

Thus have we seen what is the peculiar character of Special Geometry, strictly considered. We see that it constitutes an indispensable basis to General Geometry. Next, we have to study the philosophical character of the true science of Geometry, beginning with the great original idea of Descartes, on which it is wholly founded.

Modern, or Analytical Geometry.

General or Analytical Geometry is founded upon the transformation of geometrical considerations into equivalent analytical considerations. Descartes established the constant possibility of doing this in a uniform manner: and his beautiful conception is interesting, not only from its carrying on geometrical science to a logical perfection, but from its showing us how to organize the relations of the abstract to the concrete in Mathematics by the analytical representation of natural phenomena.

Analytical representation of figures.

The first thing to be done is evidently to find and fix a method for expressing analytically the subjects which afford the phenomena. If we can regard lines and surfaces analytically, we can so regard, henceforth, the *accidents* of these *subjects*.

Position.

Here occurs the difficulty of reducing all geometrical ideas to those of number: of substituting considerations of quantity for all considerations of quality. In dealing with this difficulty, we must observe that all geometrical ideas come under three heads:—the *magnitude*, the *figure*, and the *position* of the extensions in question. The relation of the first, magnitude, to numbers is immediate and evident: and the other two are easily brought into one; for the figure of a body is nothing else than the natural position of the points of which it is composed: and its position can not be conceived of irrespective of its figure. We have therefore only to establish the one relation between ideas of position and ideas of magnitude. It is upon this that Descartes has established the system of General Geometry.

The method is simply a carrying out of an operation which is natural to all minds. If we wish to indicate the situation of an object which we can not point out, we say how it is related to objects that are known, by assigning the magnitude of the different geometrical elements which connect it with known objects.

Those elements are what Descartes, and all other geometers after him, have called the co-ordinates of the point considered. If we know in what plane the point is situated, the co-ordinates are two. If the point may be anywhere in space, the co-ordinates can not be less than three. They may be multiplied without limit: but whether few or many, the ideas of position will have been reduced to those of magnitude, so that we shall represent the displacement of a point as produced by pure numerical variations in the values of its co-ordinates. The simplest case of all, that of *plane geometry*, is when we determine the position of a point on a plane by considering its distances from two fixed right lines, supposed to be known, and generally concluded to be perpendicular to each other. These are called axes. Next, there may be the less simple process of determining the position by the distances from two fixed points; and so on to greater and greater complications. But, from some system or other of co-ordinates being always employed, the question of position is always reduced to that of magnitude.

Position of a point.

It is clear that our only way of marking the position of a point is by the intersection of two lines. When the point is determined by the intersection of two right lines, each parallel to a fixed axis, that is the system of rectilinear co-ordinates—the most common of all. The *polar* system of co-ordinates exhibits the point by the travelling of a right line round a fixed centre of a circle of variable radius. Again, two circles may intersect, or any other two lines: so that to assign the value of a co-ordinate is the same thing as to determine the line on which the point must be situated. The ancient geometers, of course, were like ourselves in this necessary method of conceiving of position: and their geometrical *loci* were founded upon it. It was in endeavoring to form the process into a general system that Descartes created Analytical Geometry. Seeing, as we now do, how ideas of position—and, through them, all elementary geometrical ideas—can be reduced to ideas of number, we learn what it was that he effected.

Plane Curves

Descartes treated only geometry of two dimensions in his analytical method: and we will at first consider only this kind, beginning with Plane Curves.

Expression of lines by Equations.

Lines must be expressed by equations: and again, equations must be expressed by lines, when the relation of geometrical conceptions to numbers is established. It comes to the same thing whether we define a line by any one of its properties, or supply the corresponding equation between the two variable co-ordinates of the point which describes the line. If a point describes a certain line on a plane, we know that its co-ordinates bear a fixed relation to each other, which may be expressed by an appropriate equation. If the point describes no certain line, its co-ordinates must be two variables independent of each other. Its situation in the latter case can be determined only by giving at once its two co-ordinates, independently of each other: whereas, in the former case, a single co-ordinate suffices to fix its position. The second co-ordinate is then a determinate function of the first;—that is, there exists between them a certain equation of a nature corresponding to that of the line on which the point is to be found. The co-ordinates of the point each require it to be on a certain line: and again, its being on a certain line is the same thing as assigning the value of one of the two co-ordinates; which is then found to be entirely dependent on the other. Thus are lines analytically expressed by equations.

Expression of equations by lines.

By a converse argument may be seen the geometrical necessity of representing by a certain line every equation of two variables, in a determinate system of co-ordinates. In the absence of any other known property, such a relation would be a very characteristic definition; and its scientific effect would be to fix the attention immediately upon the general course of the solutions of the equation, which will thus be noted in the most striking and simple manner. There is an evident and vast advantage in this picturing of equations, which reacts strongly upon the perfecting of analysis itself. The geometrical *locus* stands before our minds as the representation of all the details that have gone to its preparation, and thus renders comparatively easy our conception of new general analytical views. This method has become entirely elementary in our day; and it is employed when we want to get a clear idea of the general character of the law which runs through a series of particular observations of any kind whatever.

Change in the line changes the equation.

Recurring to the representation of lines by equations, which is our chief object, we see that this representation is, by its nature, so faithful, that the line could not undergo any modification, even the slightest, without causing a corresponding change in the equation. Some special difficulties arise out of this perfect exactness; for since, in our system of analytical geometry, mere displacements of lines affect equations as much as real variations of magnitude or form, we might be in danger of confounding the one with the other, if geometers had not discovered an ingenious method expressly intended to distinguish them always. It must be observed that general inconveniences of this nature appear to be strictly inevitable in analytical geometry; since, ideas of position being the only geometrical ideas immediately reducible to numerical considerations, and conceptions of form not being referrible to them but by seeing in them relations of situation, it is impossible that analysis should not at first confound phenomena of form with simple phenomena of position; which are the only ones that equations express directly.

Every definition of a line is an equation.

To complete our description of the basis of analytical geometry, it is necessary to point out that not only must every defined line give rise to a certain equation between the two co-ordinates of any one of its points, but every definition of a line is itself an equation of that line in a suitable system of co-ordinates.

Considering, first, what a definition is, we say it must distinguish the defined object from all others, by assigning to it a property which belongs to it alone. But this property may not disclose the mode of generation of the object, in which case the definition is merely *characteristic;* or it may express one of its modes of generation, and in that case the definition is *explanatory*. For instance, if we say that the circle is the line which in the same form contains the largest area, we offer a characteristic definition ; whereas if we choose its property of having all its points equally distant from a fixed point, we have an explanatory definition. It is clear moreover that the characteristic definition always leaves room for an explanatory one, which further study must disclose.

It is to explanatory definitions only that what has been said of the definition of a line being an equation of that line can apply. We can not define the generation of a line without specifying a certain relation between the two simple motions, of translation or of rotation, into which the motion of the point which describes it will be decomposed at each moment. Now, if we form the most general conception of what a *system of co-ordinates* is, and if we admit all possible systems, it is clear that such a relation can be nothing else than the equation of the proposed line, in a system of co-ordinates of a corresponding nature to that of the mode of generation considered ; as in the case of the *circle*, the common definition of which may be regarded as being the polar equation of that curve, taking the centre of the circle for the pole.

This view not only exhibits the necessary representation of every line by an equation, but it indicates the general difficulty which occurs in the establishment of these equations, and therefore shows us how to proceed in inquiries of this kind which, by their nature, do not admit of invariable rules. Since every explanatory definition of a line constitutes the equation of that line, it is clear that when we find difficulty in discovering the equation of a curve by means of some of its characteristic properties, the difficulty must proceed from our taking up a designated system of co-ordinates, instead of admitting indifferently all possible systems. These systems are not all equally suitable ; and, in regard to curves, geometers think that they should almost always be referred, as far as possible, to rectilinear co-ordinates. Now, these particular co-ordinates are often not those with reference to which the equation of the curve will be found to be established by the proposed definition. It is in a certain transformation of co-ordinates then that the chief difficulty in the formation of the equation of a line really consists. The view I have given does not furnish us with a complete and certain general method for the establishment of these equations; but it may cast a useful light on the course which it is best to pursue to attain the end proposed.

Choice of co-ordinates.

The choice of co-ordinates—the preference of that system which may be most suitable to the case—is the remaining point which we have to notice.

First, we must distinguish very carefully the two views, the converse of each other, which belong to analytical geometry, viz. the relation of algebra to geometry, founded on the representation of lines by equations, and, reciprocally, the relation of geometry to algebra, founded on the picturing of equations by lines. Though the two are necessarily combined in every investigation of general geometry, and we have to pass from the one to the other alternately, and almost insensibly, we must be able to separate them here, for the answer to the question of method which we are considering is far from being the same under the two relations; so that without this distinction we could not form any clear idea of it.

In the case of the representation of lines by equations, the first object is to choose those co-ordinates which afford the greatest simplicity in the equation of each line, and the greatest facility in arriving at it. There can be no constant preference here of one system of co-ordinates. The rectilinear system itself, though often advantageous, can not be always so, and may be, in turn, less so than any other. But it is far otherwise in the converse case of the representation of equations by lines. Here the rectilinear system is always to be preferred, as the most simple and trustworthy. If we seek to determine a point by the intersection of two lines, it must be best that those lines should be the simplest possible; and this confines our choice to the rectilinear system. In constructing geometrical *loci*, that system of co-ordinates must be the best in which it is easiest to conceive the change of place of a point resulting from the change in the value of its co-ordinates; and this is the case with the rectilinear system. Again, there is great advantage in the common usage of taking the two axes perpendicular to each other, when possible, rather than with any other inclination. In representing lines by equations, we must take any inclination of the axes which may best suit the particular question; but, in the converse case, it is easy to see that rectangular axes permit us to represent equations in a more simple, and even in a more faithful manner. For if we extend the geometrical *locus* of the equation into the several unequal regions marked out by oblique axes, we shall have differences of figure which do not correspond to any analytical diversity; and the accuracy of the representation will be lost.

On the whole then, taking together the two points of view of analytical geometry, the ordinary system of rectilinear co-ordinates is superior to any other. Its high aptitude for the representation of equations must make it generally preferred, though a less perfect system may answer better in particular cases. The most essential theories in modern geometry are generally expressed by the rectilinear system. The polar system is preferred next to it, both because its opposite character enables it to solve in the simplest way the equations which are too complicated for management under the first; and because polar-co-ordinates have often the advantage of admitting of a more direct and natural concrete signification. This is the case in Mechanics, in the geometrical questions arising out of the theory of circular movement, and in almost all questions of celestial geometry.

Such was the field of the labors of Descartes, his conception of analytical geometry being designed only for the study of Plane Curves. It was Clairaut who, about a century later, extended it to the study of Surfaces and Curves of double curvature. The conception having been explained, a very brief notice will suffice for the rest.

Determination of a point in space.

With regard to Surfaces, the determination of a point in space requires that the values of three co-ordinates should be assigned. The system generally adopted, which corresponds with the rectilinear system of plane geometry, is that of distances from the point to three fixed planes, usually perpendicular to each other, whereby the point is presented as the intersection of three planes whose direction is invariable. Beyond this, there is the same infinite variety among possible systems of co-ordinates, that there is in geometry of two dimensions. Instead of the intersection of two lines, it must be that of three surfaces which determines the point; and each of the three surfaces has, in the same way, all its conditions constant, except one, which gives rise to the corresponding co-ordinates, whose peculiar geometrical effect is thus to compel the point to be situated upon that surface. Again, if the three co-ordinates of a point are mutually independent, that point can take successively all possible positions in space; but, if its position on any surface is defined, two co-ordinates suffice for determining its situation at any moment; as the proposed surface will take the place of the condition imposed by the third co-ordinate. This last co-ordinate then becomes a determinate function of the two others, they remaining independent of each other. Thus, there will be a certain equation between the three variable co-ordinates which will be permanent, and which will be the only one, in order to correspond to the precise degree of indetermination in the position of the point.

Determination of Surfaces by Equations, and of Equations by Surfaces.

In the expression of Surfaces by Equations, and again in the expression of Equations by Surfaces, the same conception is pursued as in the analytical geometry of two dimensions. In the first case, the equation will be the analytical definition of the proposed surface, since it must be verified for all the points of this surface, and for them only. If the surface undergoes any change, the equation must, as in the case of changing lines, be modified accordingly. All geometrical phenomena relating to surfaces may be translated by certain equivalent analytical conditions, proper to equations of three variables: and it is in the establishment and interpretation of this harmony that the science of analytical geometry of three dimensions essentially consists. In the second and converse case, every equation of three variables may, in general, be represented geometrically by a determinate surface, defined by the characteristic property that the co-ordinates of all its points always preserve the mutual relation exhibited in this equation.

Thus we see in this application the complement of the original idea of Descartes: and it is enough to say this, as every one can extend to surfaces the other considerations which have been indicated with regard to lines. I will only add that the superiority of the rectilinear system of co-ordinates becomes more evident in analytical geometry of three dimensions than in that of two, on account of the geometrical complication which would follow the choice of any other.

Curves of double curvature.

In determining Curves of double curvature,—which is the last elementary point of view of analytical geometry of three dimensions,—the same principle is employed. According to it, it is clear that when a point is required to be situated upon some certain curve, a single co-ordinate is enough to determine its position completely, by the intersection of this curve with the surface resulting from this co-ordinate. The two other co-ordinates of the point must thus be regarded as functions necessarily determinate, and distinct from the first. Consequently, every line, considered in space, is represented analytically no longer by a single equation, but by a system of two equations between the three co-ordinates of any one of its points. It is evident, indeed, from another point of view, that the equations which, considered separately, express a certain surface, must in combination present the line sought as the intersection of two determinate surfaces. As for the difficulty occasioned by the infinity of the number of couples of equations, through the infinity of couples of surfaces which can enter the same system of co-ordinates, and by which the line sought may be hidden under endless algebraical disguises, it must be got rid of by giving up the facilities resulting from such a variety of geometrical constructions. It is sufficient, in fact, to obtain from the analytical system established for a certain line, the system corresponding to a single couple of surfaces uniformly generated, and which will not vary except when the line itself shall change. Such is a natural use of this kind of geometrical combination, which thus affords us a certain means of recognising the identity of lines in spite of the extensive diversity of their equations.

Imperfections of Analytical Geometry.

Analytical Geometry still presents some imperfections on the side both of geometry and analysis.

In regard to Geometry, the equations can as yet represent only entire geometrical *loci*, and not determinate portions of those *loci*. Yet it is necessary, occasionally, to be able to express analytically a part of a line or surface, or even a discontinuous line or surface, composed of a series of sections belonging to distinct geometrical figures. Some progress has been made in supplying means for this purpose, to which our analytical geometry is inapplicable; but the method introduced by M. Fourier, in his labors on discontinuous functions, is too complicated to be at present introduced into our established system.

Imperfections of Analysis.

In regard to analysis, we are so far from having a complete command of analytical geometry, that we can not furnish anything like an adequate geometrical representation of analytical processes. This is not an imperfection in science, but inherent in the very nature of the subject. As Analysis is much more general than geometry, it is of course impossible to find among geometrical phenomena a concrete representation of all the laws expressed by analysis: but there is another evil which is due to our own imperfect conceptions; that, in our representations of equations of two or of three variables by lines or surfaces, we regard only the real solutions of equations, without noticing any imaginary ones. Yet these last should, in their general course, be as capable of representation as the first. Hence the graphic representation of the equation is always imperfect; and it fails altogether when the equation admits of only imaginary solutions. This brings after it, in analytical geometry of two or three dimensions, many inconveniences of less consequence, arising from the want of correspondence between various analytical modifications and any geometrical phenomena.

We have now seen what Analytical Geometry is. By this science we determine what is the analytical expression of such or such a geometrical phenomenon belonging to lines or surfaces: and, reciprocally, we ascertain the geometrical interpretation of such or such an analytical consideration. It would be interesting now to consider the most important general questions which would exemplify the manner in which geometers have actually established this beautiful harmony: but such a review is not necessary to the purpose of this Work, and would occupy too much space. We have seen what is the character of generality and simplicity inherent in the science of GEOMETRY. We must now proceed to ascertain what is the true philosophical character of the immense and more complex science of RATIONAL MECHANICS.

CHAPTER IV.

RATIONAL MECHANICS.

Its nature.

MECHANICAL phenomena are by their nature more particular, more complicated, and more concrete, than geometrical phenomena. Therefore they come after geometry in our survey; and therefore must they be pronounced to be more difficult to study, and, as yet, more imperfect. Geometrical questions are always completely independent of Mechanics, while mechanical questions are closely involved with geometrical considerations,—the form of bodies necessarily influencing the phenomena of motion and equilibrium. The simplest change in the form of a body may enhance immeasurably the difficulties of the mechanical problem relating to it, as we see in the question of the mutual gravitation of two bodies, as a result of that of all their molecules; a question which can be completely resolved only by supposing the bodies to be spherical; and thus, the chief difficulty arises out of the geometrical part of the circumstances.

Our tendency to look for the essences of things, instead of studying concrete facts, enters disastrously into the study of Mechanics. We found something of it in geometry; but it appears in an aggravated form in Mechanics, from the greater complexity of the science. We encounter a perpetual confusion between the abstract and the concrete points of view; between the logical and the physical; between the artificial conception necessary to help us to general laws of equilibrium and motion, and the natural facts furnished by observation, which must form the basis of the science. Great as is the gain of applying Mathematical analysis to Mechanics, it has set us back in some respects. The tendency to *à priori* suppositions, drawn by us from analysis where Newton wisely had recourse to observation, has made our expositions of the science less clear than those of Newton's days. Inestimable as mathematical analysis is for carrying the science on and upward, there must first be a basis of facts to employ it upon; and Laplace and others were therefore wrong in attempting to prove the elementary law of the composition of forces by analytical demonstration. Even if the science of Mechanics could be constructed on an analytical basis, it is not easy to see how such a science could ever be applied to the actual study of nature. In fact, that which constitutes the reality of Mechanics is that the science is founded on some general facts, furnished by observation, of which we can give no explanation whatever. Our business now is to point out exactly the philosophical character of the science, distinguishing the abstract from the concrete point of view, and separating the experimental department from the logical.

Its character.

We have nothing to do here with the causes or modes of production of motion, but only with the motion itself. Thus, as we are not treating of Physics, but of Mechanics, *forces* are only motions produced or tending to be produced; and two forces which move a body with the same velocity in the same direction are regarded as identical, whether they proceed from muscular contractions in an animal, or from a gravitation toward a centre, or from collision with another body, or from the elasticity of a fluid. This is now practically understood; but we hear too much still of the old metaphysical language about *forces*, and the like; and it would be wise to suit our terms to our positive philosophy.

Its object.

The business of Rational Mechanics is to determine how a given body will be affected by any different forces whatever, acting together, when we know what motion would be produced by any one of them acting alone: or, taking it the other way, what are the simple motions whose combination would occasion a known compound motion. This statement shows precisely what are the data and what the unknown parts of every mechanical question. The science has nothing to do with the action of a single force; for this is, by the terms of the statement, supposed to be known. It is concerned solely with the combination of forces, whether there results from that combination a motion to be studied, or a state of equilibrium, whose conditions have to be described.

The two general questions, the one direct, the other inverse, which constitute the science, are equivalent in importance, as regards their application. Simple motions are a matter of observation, and their combined operation can be understood only through a theory: and again, the compound result being a matter of observation, the simple constituent motions can be ascertained only by reasoning. When we see a heavy body falling obliquely, we know what would be its two simple movements if acted upon separately by the force to which it is subject,—the direction and uniform velocity which would be caused by the impulsion alone; and again, the acceleration of the vertical motion by its weight alone. The problem is to discover thence the different circumstances of the compound movement produced by the combination of the two,—to determine the path of the body, its velocity at each movement, the time occupied in falling; and we might add to the two given forces the resistance of the medium, if its law was known. The best example of the inverse problem is found in celestial mechanics, where we have to determine the forces which carry the planets round the sun, and the satellites round the planets. We know immediately only the compound movement: Kepler's laws give us the characteristics of the movement; and then we have to go back to the elementary forces by which the heavenly bodies are supposed to be impelled, to correspond with the observed result: and these forces once understood, the converse of the question can be managed by geometers, who could never have mastered it in any other way.

Such being the destination of Mechanics, we must now notice its fundamental principles, after clearing the ground by a preparatory observation.

Matter not inert in Physics.

In ancient times, men conceived of matter as being passive or inert,—all activity being produced by some external agency,—either of supernatural beings or some metaphysical entities. Now that science enables us to view things more truly, we are aware that there is some movement or activity, more or less, in all bodies whatever. The difference is merely of degree between what men call *brute matter* and animated beings. Moreover, science shows us that there are not different kinds of matter, but that the elements are the same in the most primitive and the most highly organized. If we knew of any substance which had nothing but weight, we could not deny activity even to that; for in falling it is as active as the globe itself,—attracting the earth's particles precisely as much as its own particles are attracted by the earth. Looking through the whole range of substances, up to those of the highest organization, we find everywhere a spontaneous activity, very various, and at most, in some cases, peculiar; though physiologists are more and more disposed to regard the most peculiar as a modification of antecedent kinds. However this may be, it would be purely absurd now to regard any portion of matter whatever as inert, as a matter of fact, or under the head of Physics. But in Mechanics it must be so regarded, because we can not establish any general proposition upon the abstract laws of equilibrium or motion without putting out of the question all interference with them by other and inherent forces. What we have to beware of is mixing up this logical supposition with the old notion of actual *inertia*.

Supposed inert in Mechanics.

Field of Rational Mechanics.

As for how this is to be done—we must remember what has been just said—that in Mechanics, we have nothing to do with the origin or different nature of forces; and they are all one while their mechanical operation is uniform. It is impossible to conceive of any substance as devoid of weight, for instance; yet geometers have logically to treat of bodies as without an inherent power of attraction. They treat of this power as an external force; that is, it is to them simply a force; and it does not matter to them whether it is inherent or external—whether it is attraction or impulsion—while it is the fall of the body that they have to study. And so on, through the whole range of properties of bodies. When we have so abstracted natural properties, in our logical view, as to have before us an unmixed case of the action of certain forces, and have ascertained their laws—then we can pass from abstract to concrete Mechanics, and restore to bodies their natural active properties, and interpret their action by what we have learned of the laws of motion and equilibrium. This restoration is so difficult to effect—the transition from the abstract to the concrete in Mechanics is so difficult—that, while its theoretical domain is unbounded, its practical application is singularly limited. In fact, the application of rational mechanics is limited (accurately speaking) not only to celestial phenomena, but to those of our own solar system. One would suppose that the single property of weight was manageable enough; and that of a given form intelligible enough: but there are such complications of physical circumstances—as the resistance of media, friction, etc.—even if bodies are conceived of as in a fluid state, that their mechanical phenomena can not be estimated with any accuracy. And when we proceed to electrical and chemical, and especially to physiological phenomena, we are yet more baffled. General gravitation affords us the only simple and determinate law; and even there we are perplexed, when we come to regard certain secondary actions. It may be doubted whether questions of terrestrial mechanics will ever admit—restricted as our means are—of a study at once purely rational and precisely accordant with the general laws of abstract mechanics—though the knowledge of these laws, primarily indispensable, may often lead us to frequent and valuable indications and suggestions.

Three laws of motion.

Bodies being supposed inert, the general facts, or *laws of motion* to which they are subject, are three; all results of observations.

Law of inertia.

The first is that law discovered by Kepler, which is inaptly called the *law of inertia.* According to it, all motion is rectilinear and uniform; that is, any body impelled by a single force will move in a right line, and with an invariable velocity. Instead of resorting to the old ways of pronouncing or imagining *why* it must be so, the Positive Philosophy instructs us to recognise the simple fact that it *is* so; that, through the whole range of nature, bodies move in a right line, and with a uniform velocity, when impelled by a single force.

Law of equality of action and reaction.

The second law we owe to Newton. It is that of the constant *equality of action and reaction;* that is, whenever one body is moved by another, the reaction is such that the second loses precisely as much motion, in proportion to its masses, as the first gains. Whether the movement proceeds from impulsion or attraction, is, of course, of no consequence. Newton treated this general fact as a matter of observation, and most geometers have done the same; so that there has been less fruitless search into the *why* with regard to this second law than to the first.

Law of co-existence of motions.

The third fundamental law of motion involves the principle of the independence or *co-existence of motions*, which leads immediately to what is commonly called the *composition of force.* Galileo is, strictly speaking, the true discoverer of this law, though he did not regard it precisely under the form in which it is presented here:—that any motion common to all the bodies of any system whatever does not affect the particular motions of these bodies with regard to each other; which motions proceed as if the system were motionless. Speaking strictly, we must conceive that all the points of the system describe at the same time parallel and equal straight lines, and consider that this general motion, whatever may be its velocity and direction, will not affect relative motions. No *à-priori* considerations can enter here. There is no seeing why the fact should be so, and therefore no anticipating that it would be so. On the contrary, when Galileo stated this law, he was assailed by a host of objections that his fact was logically impossible. Philosophers were ready with plenty of *à-priori* reasons that it could not be true: and the fact was not unanimously admitted till men had quitted the logical for the physical point of view. We now find, however, that no proposition in the whole range of natural philosophy is founded on observations so simple, so various, so multiplied, so easy of verification. In fact, the whole economy of the universe would be overthrown, from end to end, but for this law. A ship impelled smoothly, without rolling and pitching, has everything going on within it just the same as if it were at rest; and, in the same way, but on the grandest scale, the great globe itself rushes through space, without its motion at all affecting the movements going on on its surface. As we all know, it was ignorance of this third law of motion which was the main obstacle to the establishment of the Copernican theory. The Copernicans struggled to get rid of the insurmountable objections to which their doctrine was liable by vain metaphysical subtleties, till Galileo cleared up the difficulty. Since his time, the movement of the globe has been considered an all-sufficient confirmation of the law. Laplace points out to us that if the motion of the globe affected the movements on it, the effect could not be uniform, but must vary with the diversities of their direction, and of the angle that each direction would make with that of the earth: whereas, we know how invariable is, for instance, the oscillating movement of the pendulum, whatever may be its direction in comparison with that of the travelling globe.

It may be as well to point out that rotary motion does not enter into this case at all, but only translation, because the latter is the only motion which can be, in degree and direction, absolutely common to all the parts of a system. In a rotating system, for instance, all the parts are not at an equal distance from the centre of rotation. When the interior of a ship is affected, it is by the rolling and pitching, which are rotary movements. We may carry a watch any distance without affecting its interior movements; but it will not bear whirling.

And, again, the forward motion of the globe could be discovered by no other means than astronomical observation; whereas, the changes which occur on the surface of the earth, produced by the inequality of the centrifugal force at its different points, are sufficient evidence of its rotation, independently of all astronomical considerations whatever.

The law or rule of the composition of forces, which is involved in the general fact just stated, is, in fact, identical with it. It is only another way of expressing the same law. If a single impulsion describes a parallelogram of forces, as the scientific term is, the effect of a second will be to describe the diagonal of the parallelogram. This is nothing more than an application of the law of the independence of forces; since the motion of any body along a straight line is in no way disturbed by a general motion which carries away, parallel with itself, the whole of this right line along any other right line whatever. This consideration leads immediately to the geometrical construction expressed by the rule of the parallelogram of forces. And thus it appears that this fundamental theorem of Rational Mechanics is a true natural law; or, at least, a direct application of one of the greatest natural laws. And this is the best account to give of it, instead of looking to logic for a fallacious *à priori* deduction of it. Any analytical demonstration, too, must suppose certain portions of the case to be evident; and to talk of a thing being evident is to refer back to nature, and to depend on observation of nature.

It is worthy of remark that those who wish to make a separate law of the composition of forces, in order to avoid introducing the third law into the prolegomena of Mechanics, and to dispense with it in the exposition of Statics, are brought back to it when entering upon the study of Dynamics. Upon this alone can be based the important law of the proportion of forces to velocities. The relations of forces may be determined either by a statical or dynamical procedure. No purpose is answered by the transposition of the general fact of the independence of forces to the dynamical department of the science: it is equally necessary for the statical; and a world of metaphysical confusion is saved by laying it down as the broad basis that in fact it is.

These three laws are the experimental basis of the science of Mechanics. From them the mind may proceed to the logical construction of the science, without further reference to the external world. At least, so it appears to me; though I am far from assigning any *à-priori* reasons why more laws may not be hereafter discovered, if these three should prove to be incomplete. There can not, in the nature of things, be many more; and I would rather incur the inconvenience of the introduction of one or two, than run any risk of surrendering the positive character of the science and overstraining its logical considerations. We can not however conceive of any case which is not met by these three laws of Kepler, of Newton, and of Galileo; and their expression is so precise, that they can be immediately treated in the form of analytical equations easily obtained. As for the most extensive, important, and difficult part of the science, the mechanics of varied motion or continuous forces, we can perceive the possibility of reducing it to elementary Mechanics by the application of the infinitesimal method. For each infinitely small point of time, we must substitute a uniform motion in the place of a varied one, whence will immediately result the differential equations relative to these varied motions. We may hereafter see what results have been obtained in regard to the abstract laws of equilibrium and motion. Meantime, we see that the whole science is founded on the combination of the three physical laws just established; and here lies the distinct boundary between the physical and the logical parts of the science.

Two primary divisions. STATICS and DYNAMICS.

As for its divisions, the first and most important is into Statics and Dynamics; that is, into questions relating to equilibrium and questions relating to motion. Statics are the easiest to treat, because we abstract from them the element of time, which must enter into Dynamical questions, and complicate them. The whole of Statics corresponds to the very small portion of Dynamics which relates to the theory of uniform motions. This division corresponds well with the facts of human education in this science. The fine researches of Archimedes show us that the ancients, though far from having obtained any complete system of rational Statics, had acquired much essential knowledge of equilibrium—both of solids and fluids—while as yet wholly without the most rudimentary knowledge of Dynamics. Galileo, in fact, created that department of the science.

Secondary division. *Solids and Fluids.*

The next division is that of Solids from Fluids. This division is generally placed first, but it is unquestionable that the laws of statics and dynamics must enter into the study of solids and fluids, that of fluids requiring the addition of one more consideration,—variability of form. This however is a consideration which introduces the necessity of treating separately the molecules of which fluids are composed, and fluids as systems composed of an infinity of distinct forces. A new order of researches is introduced into Statics, relative to the form of the system in a state of equilibrium; but in Dynamics the questions are still more difficult to deal with. The importance and difficulty of the researches under this division can not be exaggerated. Their complication places even the easiest cases beyond our reach, except by the aid of extremely precarious hypotheses. We must admit the vast necessary difficulty of hydrostatics, and yet more of hydrodynamics, in comparison with statics and dynamics, properly so called, which are in fact far more advanced.

Much of the difficulty arises from the mathematical statement of the question differing from the natural facts. Mathematical fluids have no adhesion between their particles; whereas natural fluids have, more or less; and many natural phenomena are due to this adherence, small though it be in comparison with that of solids. Thus, the result of an observation of the quantity of a given fluid which will run out of a given orifice will differ widely from the result of the mathematical calculation of what it should be. Though the case of solids is easier, yet there perplexity may be introduced by the disrupting action of forces, of which abstraction must be made in the mathematical question. The theory of the rupture of solids, initiated by Galileo, Huyghens, and Leibnitz, is still in a very imperfect and precarious state, great as are the pains which have been taken with it, and much needed as it is. Not so much needed however as the mechanics of fluids, because it does not affect questions of celestial mechanics; and in this highest department alone can we, as I said before, see the complete application of rational mechanics.

There is a gap left between these two studies, which should be pointed out, though it is of secondary importance. We want a Mechanics of semi-fluids, or semi-solids,—as of sand, in relation to solids, and gelatinous conditions of fluids. Some considerations have been offered with regard to these "imperfect fluids," as they are called; but their true theory has never been established in any direct and general manner.

Such is the general view of the philosophical character of Rational Mechanics. We must now take a philosophical view of the composition of the science, in order to see how this great second department of Concrete Mathematics has attained the theoretical perfection in which it appears in the works of Lagrange, who has rendered all its possible abstract questions capable of an analytical solution, like those of geometry. We must first take a view of Statics, and then proceed to Dynamics.

SECTION I.

STATICS.

Converse methods of treatment.

THERE are two ways of treating Rational Mechanics, according as Statics are regarded directly, or as a particular case of Dynamics. By the first method we have to discover a principle of equilibrium so general as to be applicable to the conditions of equilibrium of all systems of possible forces. By the second method, we reverse the process,—ascertaining what motion would result from the simultaneous action of any proposed differing forces, and then determining what relations of these forces would render motion null.

First method. Statics by itself.

The first method was the only one possible in the early days of science; for, as I have said before, Galileo was the creator of the science of Dynamics. Archimedes, the founder of Statics, established the condition of equilibrium of two weights suspended at the ends of a straight lever; that is, he showed that the weights must be in an inverse ratio to their distances from the fulcrum of the lever. He endeavored to refer to this principle the relations of equilibrium proper to other systems of forces; but the principle of the lever is not in itself general enough for such application. The various devices by which it was attempted to extend the process, and to supply the remaining deficiencies, were relinquished when the establishment of Dynamics permitted the use of the second method,—of

Second method

Statics through Dynamics.

seeking the conditions of equilibrium through the laws of the composition of forces. It is by this last method that Varignon discovered the theory of the equilibrium of a system of forces applied upon a single point; and that D'Alembert afterward established, for the first time, the equations of equilibrium of any system of forces applied to the different points of a solid body of an invariable form. At this day, this is the method universally employed. At the first glance, it does not appear the most rational, —Dynamics being more complicated than Statics, and precedence being natural to the simpler. It would, in fact, be more philosophical to refer dynamics to statics, as has since been done; but we may observe that it is only the most elementary part of dynamics, the theory of uniform motions, that we are concerned with in treating statics as a particular case of dynamics. The complicated considerations of varied motions do not enter into the process at all.

The easiest method of applying the theory of uniform motions to statical questions is through the view that, when forces are *in equilibrio*, each of them, taken singly, may be regarded as destroying the effect of all the others together. Thus, the thing to be done is to show that any one of the forces of the system is equal, and directly opposed, to the resulting force of all the rest. The only difficulty here is in determining the resulting force; that is, in mutually compounding the given forces. Here comes in the aid of the third great law of motion, and having compounded the two first forces, we can deduce the composition of any number of forces.

Moments.

Want of unity in the method.

After having established the elementary laws of the composition of forces, geometers, before applying them to the investigation of the conditions of equilibrium, usually subject them to an important transformation, which, without being indispensable, is of eminent utility, in an analytical view, from the extreme simplification which it introduces into the algebraical expression of the conditions of equilibrium. The transformation consists in what is called the theory of *Moments*, the essential property of which is to reduce, analytically, all the laws of the composition of forces to simple additions and subtractions. Without going into an examination of this theory, it is necessary simply to say that it considers statics as a particular case of elementary dynamics, and that its value is in the simplicity which it gives to the analytical part of the process of investigation into the conditions of equilibrium. Simple, however, as may be the operation, and great as may be the practical advantage gained through the treatment of statics as a particular case of elementary Dynamics, it would be satisfactory to return, if we could, to the method of the ancients,—to leave Dynamics on one side, and proceed directly to the investigation of the laws of equilibrium regarded by itself, by means of a direct general principle of equilibrium. Geometers strove after this as soon as the general equations of equilibrium were discovered by the dynamic method. But a higher motive than even the desire to place statics in a more philosophical position impelled them to establish a direct Statical method: and this it was which caused Lagrange to carry up the whole science of Rational Mechanics to the philosophical perfection which it now enjoys.

D'Alembert made a discovery (to be treated of hereafter), by the help of which all investigation of the motion of any body or system might be converted at once into a question of equilibrium. This amounts, in fact, to a vast generalization of the second fundamental law of motion; and it has served for a century past as a permanent basis for the solution of all great dynamical questions; and it must be so applied more and more, from its high merits of simplification in the most difficult investigations. Still, it is clear that this method compels a return into statics; and Statics as independent of Dynamics, which are altogether derived from Statics. A science must be imperfectly laid down, as long as it is necessary thus to pass backward and forward between its two departments. In order to establish the necessary unity, and to provide scope for D'Alembert's principle, a complete reconstitution of Rational Mechanics was indispensable. Lagrange effected this in his admirable treatise on "Analytical Mechanics," the leading conception of which must be the basis of all future labors of geometers upon the laws of equilibrium and motion, as we have seen that the great idea of Descartes is with regard to geometrical speculations.

Virtual Velocities.

The principle of Virtual Velocities,—the one which Lagrange selected from among the properties of equilibrium,—had been discovered by Galileo in the case of two forces, as a general property manifested by the equilibrium of all machines. John Bernouilli extended it to any number of forces, composing any system. Varignon afterward expressly pointed out the universal use that might be made of it in Statics. The combination of it with D'Alembert's principle led Lagrange to conceive of the whole of Rational Mechanics as deduced from a single fundamental theorem, and to give it that rigorous unity which is the highest philosophical perfection of a science.

The clearest idea of the system of virtual velocities may be obtained by considering the simple case of two forces, which was that presented by Galileo. We suppose two forces balancing each other by the aid of any instrument whatever. If we suppose that the system should assume an infinitely small motion, the forces are, with regard to each other, in an inverse ratio to the spaces traversed by their points of application in the path of their directions. These spaces are called virtual velocities, in distinction from the real velocities which would take place if the equilibrium did not exist. In this primitive state, the principle, easily verified with regard to all known machines, offers great practical utility; for it permits us to obtain with ease the mathematical condition of equilibrium of any machine whatever, whether its constitution is known or not. If we give the name of virtual momentum (or simply of momentum in its primitive sense) to the product of each force by its virtual velocity,—a product which in fact then measures the effort of the force to move the machine,—we may greatly simplify the statement of the principle in merely saying that, in this case, the momentum of the two forces must be equal and of opposite signs, that there may be equilibrium, and that the positive or negative sign of each momentum is determined according to that of the virtual velocity, which will be considered positive or negative according as, by the supposed motion, the projection of the point of application would be found to fall upon the direction of the force or upon its prolongation. This abridged expression of the principle of virtual velocities is especially useful for the statement of this principle in a general manner, with regard to any system of forces whatever. It is simply this: that the algebraic sum of the virtual moments of all forces, estimated according to the preceding rule, must be null to cause equilibrium: and this condition must exist distinctly with regard to all the elementary motions which the system might assume in virtue of the forces by which it is animated. In the equation, containing this principle, furnished by Lagrange, the whole of Rational Mechanics may be considered to be implicitly comprehended.

While the theorem of virtual velocities was conceived of only as a general property of equilibrium, it could be verified by observing its constant conformity with the ordinary laws of equilibrium, otherwise obtained, of which it was a summary, useful by its simplicity and uniformity. But, if it was to be a fundamental principle, a basis of the whole science, it must be underived, or at least capable of being presented in its preliminary propositions as a matter of observation. This was done by Lagrange, by his ingenious demonstration through a system of pulleys. He exhibited the theorem of virtual velocities very easily by imagining a single weight which, by means of pulleys suitably constructed, replaces simultaneously all the forces of the system.* Many other demonstrations have been furnished; but, while more complicated, they are not logically superior. From the philosophical point of view it is clear that this general theorem, being a necessary consequence of the fundamental laws of motion, can be deduced in various ways, and becomes practically the point of departure of the whole of Rational Mechanics. A perfect unity having been established by this principle, we need not look for any others; and we may rest assured that Lagrange has carried the co-ordination of the science as far as it can go. The only possible object would be to simplify the analytical researches to which the science is now reduced; and nothing can be conceived more admirable for this purpose than Lagrange's adaptation of the principle of virtual velocities to the uniform application of mathematical analysis.

Striking as is the philosophical eminence of this principle, there are difficulties enough in its use to prevent its being considered elementary, so far as to preclude the consideration of any other in a course of dogmatic teaching. It is for this reason that I have referred to the dynamic method, properly so called, which is the only one in general use at present. All other considerations must however be only provisional. Lagrange's method is at present too new; but it is impossible that it should for ever remain in the hands of a small number of geometers, who alone shall be able to make use of its admirable properties. It must become as popular in the mathematical world as the great geometrical conception of Descartes: and this general progress would be almost accomplished if the fundamental ideas of transcendental analysis were as widely spread as they ought to be.

Theory of Couples.

The greatest acquisition, since the regeneration of the science by Lagrange, is the conception of M. Poinsot,—the theory of Couples, which appears to me to be far from being sufficiently valued by the greater number of geometers. These Couples, or systems of parallel forces, equal and contrary, had been merely remarked before the time of M. Poinsot, as a sort of paradox in Statics. He seized upon this idea, and made it the subject of an extended and original theory relating to the transformation, composition, and use of these singular groups, which he has shown to be endowed with properties remarkable for their generality and simplicity. He used the dynamic method in his study of the conditions of equilibrium: but he presented it, by the aid of his theory of couples, in a new and simplified aspect. But his conception will do more for dynamics than for statics; and it has hardly yet entered upon its chief office. Its value will be appreciated when it is found to render the notion of the movements of rotation as natural, as familiar, and almost as simple, as that of forward movement or translation.

Share of equations in producing equilibrium.

One more consideration should, I think, be adverted to before we quit the subject of statics as a whole. When we study the nature of the equations which express the conditions of equilibrium of any system of forces, it seems to me not enough to establish that the sum of these equations is indispensable for equilibrium. I think the further statement is necessary,—in what degree each contributes to the result. It is clear that each equation must destroy some one of the possible motions that the body would make in virtue of existing forces; so that the whole of the equation must produce equilibrium by leaving an impossibility for the body to move in any way whatever. Now the natural state of things is for movement to consist of rotation and translation. Either of these may exist without the other; but the cases are so extremely rare of their being found apart, that the verification of either is regarded by geometers as the strongest presumption of the existence of the other. Thus, when the rotation of the sun upon its axis was established, every geometer concluded that it had also a progressive motion, carrying all its planets with it, before astronomers had produced any evidence that such was actually the case. In the same way we conclude that certain planets, travelling in their orbits, rotate round their axes, though the fact has not yet been verified. Some equations must therefore tend to destroy all progressive motion, and others all motion of rotation. How many equations of each kind must there be?

It is clear that, to keep a body motionless, it must be hindered from moving according to three axes in different planes—commonly supposed to be perpendicular to each other. If a body can not move from north to south, nor the reverse; nor from east to west, nor the reverse; nor up, nor down, it is clear that it can not move at all. Movement in any intermediate direction might be conceived of as partial progression in one of these, and is therefore impossible. On the other hand, we can not reckon fewer than three independent elementary motions; for the body might move in the direction of one of the axes, without having any translation in the direction of either of the others. Thus we see that, in a general way, three equations are necessary, and three are sufficient to establish the absence of translation; each being specially adapted to destroy one of the three progressive motions of which the body is capable. The same view presents itself with regard to the other motion—of rotation. The mechanical conception is more complicated; but it is true, as in the simpler case, that motion is possible in only three directions—in three co-ordinated planes, or round three axes. Three equations are necessary and sufficient here also; and thus we have six which are indispensable and sufficient to stop all motion whatever.

When, instead of supposing any system of forces whatever as the subject of the question, we particularize any, we get rid of more or fewer possible movements. Having excluded these, we may exclude also their corresponding equations, retaining only those which relate to the possible motions that remain. Thus, instead of having to deal with six equations necessary to equilibrium, there may be only three, or two, or even one, which it will be easy enough to obtain in each case. These remarks may be extended to any restrictions upon motion, whether resulting from the special constitution of the system of forces, or from any other kind of control, affecting the body under notice. If, for instance, the body were fastened to a point, so that it could freely rotate but not advance, three equations would suffice: and again, if it is fastened to two fixed points, two equations are enough; and even one, if these two fixed points are so placed as to prevent the body from moving on the axis between them. Finally, its being attached to three fixed points, not in a right line, will prevent its moving at all, and establish equilibrium without any condition, whatever may be the forces of the system. The spirit of this analysis is entirely independent of any method by which the equations of equilibriums will have been obtained: but the different general methods are far from being equally suitable to the application of this rule. The one which is best adapted to it is, undoubtedly, the Statical one, properly so called, founded, as has been shown, on the principle of virtual velocities. In fact, one of the characteristic properties of this principle is the perfect precision with which it analyses the phenomena of equilibrium, by distinctly considering each of the elementary motions permitted by the forces of the system, and furnishing immediately an equation of equilibrium specially relating to this motion.

Connection of the concrete with the abstract question.

When we come to the inquiry how geometers apply the principles of abstract Mechanics to the properties of real bodies, we must state that the only complete application yet accomplished is in the question of terrestrial gravity. Now, this is a subject which can not, logically, be treated under the head of Mechanics, as it belongs to Physics. It is sufficient to explain that the statical study of terrestrial gravity becomes convertible into that of centres of gravity; and that all confusion between the two departments of research would be avoided if we accustomed ourselves to class the theory of centres of gravity among the questions of pure geometry. In seeking the centre of gravity as (according to the logical denomination of the ancient geometers) the centre of mean distances, we remove all traces of the mechanical origin of the question, and convert it into this problem of general geometry:—Given, any system of points disposed in a determinate way with regard to each other, to find a point whose distance to any plane shall be a mean between the distances of all the given points to the same plane.—The abstraction of all consideration of gravity is an assistance in every way. The simple geometrical idea is precisely what we want in most of the principal theories of Rational Mechanics, and especially when we contemplate the great dynamic properties of the centre of mean distances; in which study the idea of gravity becomes a mere encumbrance and perplexity. It is true that, by proceeding thus, we exclude the question from the domain of Mechanics, to place it in that of Geometry. I should have so classed it but for an unwillingness to break in upon established customs. However it may be as to the matter of arrangement, it is highly important for us not to misapprehend the true nature of the question.—The integral calculus offers the means of surmounting those difficulties in determining the centre of gravity which are imposed by the conditions of the question. But, the integrations in this case being more complicated than those to which they are analogous—those of quadratures and cubatures—their precise solution is, owing to the extreme imperfection of the integral Calculus, much more rarely obtained. It is a matter of high importance, however, to be able to introduce the consideration of the centre of gravity into general theories of analytical mechanics.

Such is, then, the relation of terrestrial gravitation to the science of abstract Statics. As for universal gravitation, no complete study has yet been made of it, except in regard to spherical bodies. What we know of the law of gravitation would easily enable us to compute the mutual attraction of all known bodies, if the conditions of each body were understood by us: but this is not the case. For instance, we know nothing of the law of density in the interior of the heavenly bodies. It is still true that the primitive theorems of Newton on the attraction of spherical bodies are the most useful part of our knowledge in this direction.

Gravity is the only natural force that we are practically concerned with in Rational Statics: and we see, by this, how backward this science is in regard to universal gravitation. As for the exterior general circumstances, such as friction, resistance of media, and the like, which are altogether excluded in the establishment of the rational laws of Mechanics, we can only say that we are absolutely ignorant of the way to introduce them into the fundamental relations afforded by analytical Mechanics, because we have nothing to rely on, in working them, but precarious and inaccurate hypotheses, unfit for scientific use.

Equilibrium of fluids.

As for the theory of equilibrium in regard to fluid bodies—the application which it remains for us to notice—those bodies must be regarded as either liquid or gaseous.

Hydrostatics.

Hydrostatics may be treated in two ways. We may seek the laws of the equilibrium of fluids, according to statical considerations proper to that class of bodies: or we may look for them among the laws which relate to solids, allowing for the new characteristics resulting from fluidity.

The first method, being the easiest, was in early times the only one employed. Till a rather recent time, all geometers employed themselves in proposing statical principles peculiar to fluids; and especially with regard to the grand question of the figure of the earth, on the supposition that it was once fluid. Huyghens first endeavored to resolve it, taking for his principle of equilibrium the necessary perpendicularity of weight at the free surface of the fluid. Newton's principle was the necessary equality of weight between the two fluid columns going from the centre—the one to the pole, the other to some point of the equator. Bouguer showed that both methods were bad, because, though each was incontestable, the two failed, in many cases, to give the same form to the fluid mass in equilibrium. But he, in his turn, was wrong in believing that the union of the two principles, when they agreed in indicating the same form, was sufficient for equilibrium. It was Clairaut who, in his treatise on the form of the earth, first discovered the true laws of the case, setting out from the evident consideration of the isolated equilibrium of any infinitely small canal; and, tried by this criterion, he showed that the combination required by Bouguer might take place without equilibrium happening. Several great geometers, proceeding on Clairaut's foundation, have carried on the theory of the equilibrium of fluids a great way. Maclaurin was one of those to whom we owe much; but it was Euler who brought up the subject to its present point, by founding the theory on the principle of equal pressure in all directions. Observation of the statical constitution of fluids indicates this as a general law; and it furnishes the requisite equations with extreme facility.

It was inevitable that the mathematical theory of the equilibrium of fluids should, in the first place, be founded, as we have seen that it was, on statical principles peculiar to this kind of bodies: for, in early days, the characteristic differences between solids and fluids must have appeared too great for any geometer to think of applying to the one the general principles appropriated to the other. But, when the fundamental laws of hydrostatics were at length obtained, and men's minds were at leisure to estimate the real diversity between the theories of fluids and of solids, they could not but endeavor to attach them to the same general principles, and perceive the necessary applicability of the fundamental rules of Statics to the equilibrium of fluids, making allowance for the attendant variability of form. But, before hydrostatics could be comprehended under Statics, it was necessary that the abstract theory of equilibrium should be made so general as to apply directly to fluids as well as solids. This was accomplished when Lagrange supplied, as the basis of the whole of Rational Mechanics, the single principle of Virtual Velocities. One of its most valuable properties is its being as directly applicable to fluids as to solids. From that time, Hydrostatics, ceasing to be a natural branch of science, has taken its place as a secondary division of Statics. This arrangement has not yet been familiarly admitted; but it must soon become so.

Liquids.

Gases.

To see how the principle of Virtual Velocities may lead to the fundamental equations of the equilibrium of fluids, we have to consider that all that such an application requires, is to introduce among the forces of the system under notice one new force,—the pressure exerted upon each molecule, which will introduce one term more into the general equation. Proceeding thus, the three general equations of the equilibrium of fluids, employed when hydrostatics was treated as a separate branch, will be immediately reached. If the fluid be a liquid, we must have regard to the condition of incompressibility,—of change of form without change of volume. If the fluid be gaseous, we must substitute for the incompressibility that condition which subjects the volume of the fluid to vary according to a determinate function of the pressure; for instance, in the inverse ratio of the pressure, according to the physical law on which Mariotte has founded the whole Mechanics of the gases. We know but too little yet of these gaseous conditions; for Mariotte's law can at present be regarded only as an approximation,—sufficiently exact for average circumstances, but not to be rigorously applied in any case whatever.

Some confirmation of the philosophical character of this method of treating hydrostatics arises from its enabling us to pass, almost insensibly, from the order of bodies of invariable form to that of the most variable of all, through intermediate classes,—as flexible and elastic bodies,—whereby we obtain, in an analytical view, a natural filiation of subjects.

We have seen how the department of Statics has been raised to that high degree of speculative perfection which transforms its questions into simple problems of Mathematical Analysis. We must now take a similar review of the other department of general Mechanics,—that more extended and more complicated study which relates to the laws of Motion.

SECTION II.

DYNAMICS.

Object.

THE object of Dynamics is the study of the varied motions produced by *continuous forces*. The Dynamics of varied motions or continuous forces includes two departments,—the motion of a point, and that of a body. From the positive point of view, this means that, in certain cases, all the parts of the body in question have the same motion, so that the determination of one particle serves for the whole; while in the more general case, each particle of the body, or each body of the system, assuming a distinct motion, it is necessary to examine these different effects, and the action upon them of the relations belonging to the system under notice. The second theory being more complicated than the first, the first is the one to begin with, even if both are deduced from the same principles.

With regard to the motion of a point, the question is to determine the circumstances of the compound curvilinear motion, resulting from the simultaneous action of different continuous forces, it being known what would be the rectilinear motion of the body if influenced by any one of these forces. Like every other, this problem admits of a converse solution.

Theory of rectilinear motion.

But here intervenes a preliminary theory, which must be noticed before either of the two departments can be entered upon. This theory is popularly called the theory of rectilinear motion, produced by a single continuous force acting indefinitely in the same direction. It may be asked why we want this, after having said that the effect of each separate force is supposed to be known, and the effect of their union the thing to be sought. The answer to this is, that the varied motion produced by each continuous force may be defined in several ways, which depend on each other, and which could never be given simultaneously, though each may be separately the most suitable; whence results the necessity of being able to pass from any one of them to all the rest. The preliminary theory of varied motion relates to these transformations, and is therefore inaptly termed the study of the action of a single force. These different equivalent definitions of the same varied motions result from the simultaneous consideration of the three distinct but co-related functions which are presented by it,—space, velocity, and force, conceived as dependent on time elapsed. Taking the most extended view, we may say that the definition of a varied motion may be given by any equation containing at once these four variables, of which only one is independent,—time, space.

velocity, and force. The problem will consist in deducing from this equation the distinct determination of the three characteristic laws relating to space, velocity, and force, as a function of time, and, consequently, in mutual correlation. This general problem is always reducible to a purely analytical research, by the help of the two dynamical formulas which express, as a function of time, velocity, and force, when the law of space is supposed to be known. The infinitesimal method leads to these formulas with the utmost ease, the motion being considered uniform during an infinitely small interval of time, and as uniformly accelerated during two consecutive intervals. Thence the velocity, supposed to be constant at the instant, according to the first consideration, will be naturally expressed by the differential of the space, divided by that of the time; and, in the same way, the continuous force, according to the second consideration, will evidently be measured by the relation between the infinitely small increment of the velocity, and the time employed in producing this increment.

Lagrange's conception of transcendental analysis excluding him from this use of the infinitesimal method for the establishment of the two foregoing dynamic formulas, he was led to present this theory under another point of view, more important than seems to be generally supposed. In his Theory of Analytical Functions, he has shown that this dynamic consideration really consists in conceiving any varied motion as compounded, each moment, of a certain uniform motion and another motion uniformly varied,—likening it to the vertical motion of a heavy body under a first impulsion. Lagrange has not given its due advantage to this conception, by developing it as he might have done. In fact, it supplies a complete theory of the assimilation of motions, exactly like the theory of the contracts of curves and surfaces, in the department of geometry. Like that theory, it removes the limits within which we supposed ourselves to be confined, by disclosing to us, in an abstract way, a much more perfect measure of all varied motion than we obtain by the ordinary theory, though reasons of convenience compel us to abide by the method originally adopted.

Motion of a point.

The first case or department of rational dynamics,—that of the motion of a point, or of a body which has all its points or portions affected by the same force,—relates to the study of the curvilinear motion produced by the simultaneous action of any different continuous forces. This case divides itself again into two,—according as the mobile point is free, or as it is compelled to move in a single curve, or on a given surface. The fundamental theory of curvilinear motion may be established in either case, in a different way; each being susceptible of direct treatment, and of being connected with the other. In the first case, in order to deduce the second, we have only to regard the active or passive resistance of the prescribed curve or surface as a new force to be added to the others proposed. In the other way, we have only to consider the moving point as compelled to describe the curve which it must traverse; and this is enough to afford the fundamental equations, though this curve may then be primitively unknown.

Motions of a system.

The other, more real and more difficult case, is that of the motion of a system of bodies in any way connected, whose proper motions are altered by the conditions of their connection. There is a new elementary conception about the measurement of forces which some geometers declare to be logically deducible from antecedent considerations, and to which they would assign the place and title of a fourth law of motion. For the sake of convenience, we may make it into a fourth law of motion; but such is not its philosophical character. The idea is, that forces which impress the same velocity on different masses are to each other exactly as those masses; or, in other words, that the forces are proportional to the masses, as we have seen them, under the third law of motion, to be proportional to the velocities. All phenomena, such as the communication of motion by collision, or in any other way, have tended to confirm the supposition of this new kind of proportion. It evidently results from this, that when we have to compare forces which impress different velocities on unequal masses, each must be measured according to the product of the mass upon which it acts by the corresponding velocity. This product is called by geometers *quantity of motion;* and it determines the *percussion* of a body, and also the *pressure* that a body may exercise against any fixed obstacle to its motion.

Proceeding to the second dynamical case, we see that the characteristic difficulty of this order of questions consists in the way of estimating the connection of the different bodies of the system, in virtue of which their mutual reactions will necessarily affect the motions which each would take if alone; and we can have no *à-priori* knowledge of what the alterations will be. In the case of the pendulum, for instance, the particles nearest the point of suspension, and those furthest from it, must react on each other by their connection—the one moving faster and the other slower than if they had been free; and no established dynamic principle exists revealing the law which determines these reactions. Geometers naturally began by laying down a principle for each particular case; and many were the principles thus offered, which turned out to be only remarkable theorems furnished simultaneously by fundamental dynamic equations. Lagrange has given us, in his "Analytical Mechanics," the general history of this series of labors; and very interesting it is, as a study of the progressive march of the human intellect. This method of proceeding continued till the time of D'Alembert, who put an end to all these isolated researches by seeing how to compute the reactions of the bodies of a system in virtue of their connection, and establishing the fundamental equations of the motion of any system. By the aid of the great principle which bears his name, he made questions of motion merge in simple questions of equilibrium. The principle

D'Alembert's principle.

is simply this. In the case supposed, the natural motion clearly divides itself into two—the one which subsists and the one which has been destroyed. By D'Alembert's view, all these last, or in other words, all the motions that have been lost or gained by the different bodies of the system by their reaction, necessarily balance each other, under the conditions of the connection which characterizes the proposed system. James Bernouilli saw this with regard to the particular case of the pendulum; and he was led by it to form an equation adapted to determine the centre of oscillation of the most simple system of weight. But he extended the resource no further; and what he did detracts nothing from the credit of D'Alembert's conception, the excellence of which consists in its entire generality.

In D'Alembert's hands the principle seemed to have a purely logical character. But its germ may be recognised in the second law of motion, established by Newton, under the name of the equality of reaction and action. They are, in fact, the same, with regard to two bodies only acting upon each other in the line which connects them. The one is the greatest possible generalization of the other; and this way of regarding it brings out its true nature, by giving it the physical character which D'Alembert did not impress upon it. Henceforth therefore we recognise in it the second law of motion, extended to any number of bodies connected in any manner.

We see how every dynamical question is thus convertible into one of Statics, by forming, in each case, equations of equilibrium between the destroyed motions. But then comes the difficulty of making out what the destroyed motions are. In endeavoring to get rid of the embarrassing consideration of the quantities of motion lost or gained, Euler, above others, has supplied us with the method most suitable for use—that of attributing to each body a quantity of motion equal and contrary to that which it exhibits, it being evident that if such equal and contrary motion could be imposed upon it, equilibrium would be the result. This method contemplates only the primitive and the actual motions which are the true elements of the dynamic problem—the given and the unknown; and it is under this method that D'Alembert's principle is habitually conceived of. Questions of motion being thus reduced to questions of equilibrium, the next step is to combine D'Alembert's principle with that of virtual velocities. This is the combination proposed by Lagrange, and developed in his "Analytical Mechanics," which has carried up the science of abstract Mechanics to the highest degree of logical perfection—that is, to a rigorous unity. All questions that it can comprehend are brought under a single principle, through which the solution of any problem whatever offers only analytical difficulties.

D'Alembert immediately applied his principle to the case of fluids—liquid and gaseous, which evidently admit of its use as well as solids, their peculiar conditions being considered. The result was our obtaining general equations of the motion of fluids, wholly unknown before. The principle of virtual velocities rendered this perfectly easy, and again left nothing to be desired, in regard to concrete considerations, and presented none but analytical difficulties. We must admit, however, that our actual knowledge obtained under this theory is extremely imperfect owing to insurmountable difficulties in the integrations required. If it was so in questions of pure Statics, much more must it be so in the more complex dynamical questions. The problem of the flow of a gravitating liquid through a given orifice, simple as it appears, has never yet been resolved. To simplify as far as they could, geometers have had recourse to Daniel Bernouilli's hypothesis of the parallelism of sections, which admits of our considering motion in regard to horizontal laminæ instead of particle by particle. But this method of considering each horizontal lamina of a liquid as moving altogether, and taking the place of the following, is evidently contrary to the fact in almost all cases. The lateral motions are wholly abstracted, and their sensible existence imposes on us the necessity of studying the motion of each particle. We must then consider the science of hydrodynamics as being still in its infancy, even with regard to liquids, and much more with regard to gases. Yet, as the fundamental equations of the motions of fluids are irreversibly established, it is clear that what remains to be accomplished is in the direction of mathematical analysis alone.

Results.

Such is the Method of Rational Mechanics. As for the great theoretical results of the science—the principal general properties of equilibrium and motion thus far discovered—they were at first taken for real principles, each being destined to furnish the solution of a certain order of new problems in Mechanics. As the systematic character of the science has come out, however, these supposed principles have shown themselves to be mere theorems—necessary results of the fundamental theories of abstract Statics and Dynamics.

Statical theorems.

Law of repose.

Of these theorems, two belong to Statics. The most remarkable is that discovered by Torricelli with regard to the equilibrium of heavy bodies. It consists in this; that when any system of heavy bodies is in a situation of equilibrium, its centre of gravity is necessarily placed at the lowest or highest possible point, in comparison with all the positions it might take under any other situation of the system. Maupertuis afterward, by his working out of his *Law of repose*, gave a large generalization to this theorem of Torricelli's, which at once became a mere particular case under that law; Torricelli's applying merely to cases of terrestrial gravitation, while that of Maupertuis extends throughout the whole sphere of the great natural attractive forces.

Stability and instability of equilibrium.

The other general property relating to equilibrium may be regarded as a necessary complement of the former. It consists in the fundamental distinction between the cases of stability and instability of equilibrium. There being no such thing in nature as abstract repose, the term is applied here to that state of stable equilibrium which exists where the centre of gravity is placed as low as possible; while unstable equilibrium is that which is popularly called equilibrium; and it exists when the centre of gravity is placed as high as possible. Maupertuis's theorem consisted in this—that the situation of equilibrium of any system is always that in which the sum of *vires vivæ* (active forces) is a maximum or a minimum; and the one under notice, developed by Lagrange, consists in this—that in any system equilibrium is stable or unstable according as the sum of *vires vivæ* is a maximum or a minimum. Observation teaches the facts in the most simple cases; but it requires a large theory to exhibit to geometers that the distinction is equally applicable to the most compound systems.

Dynamical theorems.

Conservation of the motion of the centre of gravity.

Proceeding to the theorems relative to dynamics, the most direct way of establishing them is that used by Lagrange—exhibiting them as immediate consequences of the general equation of dynamics, deduced from the combination of D'Alembert's principle with the principle of virtual velocities. The first theorem is that of the conservation of the motion of the centre of gravity, discovered by Newton. Newton showed that the mutual action of the bodies of any system, whether of attraction, impulsion, or any other—regard being had to the constant equality between action and reaction—can not in any way affect the state of the centre of gravity; so that if there were no accelerating forces besides, and if the exterior forces of the system were reduced to instantaneous forces, the centre of gravity would remain immovable, or would move uniformly in a right line. D'Alembert generalized this property, and exhibited it in such a form that every case in which the motion of the centre of gravity has to be considered may be treated as that of a single molecule. It is seldom that we form an idea of the entire theoretical generality of such great results as those of rational Mechanics. We think of them as relating to inorganic bodies, or as otherwise circumscribed; but we can not too carefully remember that they apply to all phenomena whatever; and in virtue of this universality alone are the basis of all real science.

Principle of areas.

The second general theorem of dynamics is the principle of areas, the first perception of which is attributable to Kepler. In its simplest form it is this: that if the accelerating force of any molecule tends constantly toward a fixed point, the vector radius of the moving body describes equal areas in equal times round the fixed point; so that the area described at the end of any time increases in proportion to the time: and the reciprocal fact is clear,—that the evidence of the areas and the times proves the action upon the body of a force directed toward the fixed point. This discovery of Kepler's is the more remarkable for having been made before dynamics had been really created by Galileo. Its importance in astronomy we shall see hereafter. But though, in its simplest form, it is one of the bases of celestial

Mechanics, it is, in fact, only the simplest particular case of the great general theorem of areas, exhibited in the middle of the last century by D'Arcy, Daniel Bernouilli, and Euler. Kepler's discovery related only to the motion of a point, while the later one refers to the motion of any system of bodies, acting on each other in any manner whatever; which constitutes a case, not only more complex, but different, on account of the mutual actions involved. It yields proof, however, that though the area described by the vector radius of each molecule may be altered by reciprocal actions, the sum of the areas described will remain invariable in a given time, and will increase therefore in proportion to the time. As the theorem of the centre of gravity determines all that relates to motions of translation, this determines all that relates to motions of rotation: and the two together are sufficient for the complete study of the motion of any system of bodies, in either direction. And here comes in the facility afforded by M. Poinsot's conception—referred to under the head of Statics. By substituting for the areas or momentum of the geometers, the couples engendered by the proposed forces, a philosophical completeness is given to the theory, and a concrete value, and proper dynamic direction, to what was before a simple geometrical expression of a part of the fundamental equations of motion.

The invariable plane.

Laplace elicited from the theory of areas that dynamic property which he called the *invariable plane*, the consideration of which is highly important in celestial mechanics. It is in the study of astronomy that the importance fully appears of the determination of a plane, whose direction is unaffected by the mutual action of different bodies in our own solar system; for we thus obtain a point of reference, a necessarily fixed term of comparison, by which to estimate the variations of the heavenly bodies. We are far from having yet attained precision in the determination of the situation of this plane; but this does not impair the character of the theorem in its relation to rational Mechanics. Again, we are indebted to Poinsot, who, by simplifying, has once more extended the process to which his method is applied: and he has repaired an important omission made by Laplace, in taking into the account the smaller areas described by satellites, and their rotation, and that of the sun itself; whereas Laplace has attended only to the larger areas described by the planets in their course round the sun.

Moment of inertia.

Principal axes.

Finally, there are Euler's theorems of the *moment of inertia*, and the *principal axes*, which are among the most important general results of rational Mechanics. By means of these, we are able to arrive at a complete analysis of the motion of rotation. By means of all the theorems just touched upon, we are put in the direct way to determine the entire motion of any body, or system of bodies whatever. Besides them, geometers have discovered some which are less general, but, though by no means indispensable, yet very important from the simplification they introduce into special researches. Students will recognise their functions, when their mere names are presented; which is all that our space allows: I refer to the theorem of the conservation of active forces,—singularly important in its applications to industrial Mechanics: the theorem, improperly called *the principle of the least action*, as old as Ptolemy, who observed that reflected light takes the shortest way from one point to another,—an observation which was the basis of Maupertuis's discovery of this property: and lastly, a theorem not usually classed with the foregoing, yet worthy of no less esteem,—the theorem of the *co-existence of small oscillations*, of Daniel Bernouilli. This discovery is as important in its physical as its logical bearings; and it explains a multitude of facts which, clearly known, could not be referred to their principles. It consists in showing that the infinitely small oscillations caused by the return of any system of forces to a state of stable equilibrium coexist without interference, and can be treated separately.

This reference to the principal general theorems hitherto discovered in Rational Mechanics concludes our review of the second branch of Concrete Mathematics.

Conclusion.

As for our review of the whole science, I wish I could better have communicated my own profound sense of the nature of this immense and admirable science, which the necessary basis of the whole of Positive Philosophy, constitutes the most unquestionable proof of the compass of the human intellect. But I hope that those who have not the misfortune to be wholly ignorant of this fundamental science may, according to the process of thought which I have indicated, attain some clear idea of its philosophical character.

To preserve complete the philosophical arrangement of Mathematics in its present state, I ought to consider here a third branch of Concrete Mathematics; the application of analysis to thermological phenomena, according to the discoveries of Fourier. But, to avoid too great a breach of customary arrangement, I have reserved the subject, and shall place Thermology among the departments of Physics.

Mathematical philosophy being now completely characterized, we shall proceed to examine its application to the study of Natural Phenomena, in their various orders, ranked according to their degree of simplicity. By this character alone can they cast light back again upon the science which explains them; and under this character alone can they be suitably estimated. According to the natural order laid down at the beginning, we now proceed to that class of phenomena with which Mathematics is most concerned,—the phenomena of ASTRONOMY.

BOOK II.

ASTRONOMY.

CHAPTER I.

GENERAL VIEW.

Its nature.

It is easy to describe clearly the character of astronomical science, from its being thoroughly separated in our time, from all theological and metaphysical influence. Looking at the simple facts of the case, it is evident that though three of our senses take cognizance of distant objects, only one of the three perceives the stars. The blind could know nothing of them; and we who see, after all our preparation, know nothing of stars hidden by distance, except by induction. Of all objects, the planets are those which appear to us under the least varied aspect. We see how we may determine their forms, their distances, their bulk, and their motions, but we can never know anything of their chemical or mineralogical structure; and, much less, that of organized beings living on their surface. We may obtain positive knowledge of their geometrical and mechanical phenomena; but all physical, chemical, physiological, and social researches, for which our powers fit us on our own earth, are out of the question in regard to the planets. Whatever knowledge is obtainable by means of the sense of Sight, we may hope to attain with regard to the stars, whether we at present see the method or not; and whatever knowledge requires the aid of other senses, we must at once exclude from our expectations, in spite of any appearances to the contrary. As to questions about which we are uncertain whether they finally depend on Sight or not,—we must patiently wait, for an ascertainment of their character, before we can settle whether they are applicable to the stars or not. The only case in which this rule will be pronounced too severe is that of questions of temperatures. The mathematical thermology created by Fourier may tempt us to hope that, as he has estimated the temperature of the space in which we move, we may in time ascertain the mean temperature of the heavenly bodies: but I regard this order of facts as for ever excluded from our recognition. We can never learn their internal constitution, nor, in regard to some of them, how heat is absorbed by their atmosphere. Newton's attempt to estimate the temperature of the comet of 1680 at its perihelion could accomplish nothing more, even with the science of our day, than show what would be the temperature of our globe in the circumstances of that comet. We may therefore define Astronomy as the science by which we discover the laws of the geometrical and mechanical phenomena presented by the heavenly bodies.

Definition.

Restriction.

It is desirable to add a limitation which is important, though not of primary necessity. The part of the science which we command from what we may call the Solar point of view is distinct, and evidently capable of being made complete and satisfactory; while that which is regarded from the Universal point of view is in its infancy to us now, and must ever be illimitable to our successors of the remotest generations. Men will never compass in their conceptions the whole of the stars. The difference is very striking now to us who find a perfect knowledge of the solar system at our command, while we have not obtained the first and most simple element in sidereal astronomy—the determination of the stellar intervals. Whatever may be the ultimate progress of our knowledge in certain portions of the larger field, it will leave us always at an immeasurable distance from understanding the universe.

Throughout the whole range of science, there exists a constant and necessary harmony between our needs and our knowledge. We shall find this to be true everywhere. The fact is, we need to know only what, in some way or other, acts upon us; and the influence which acts upon us becomes, in turn, our means of knowledge. This is evidently and remarkably true in regard to Astronomy. It is of the highest importance to us to know the laws of the solar system: and we have attained great precision with regard to them; but, if the knowledge of the starry universe is forbidden to us, it is clear that it is of no real consequence to us, except as a gratification of our curiosity. The interior mechanism of each solar system is essentially independent of the mutual action of distant suns; as it may well be, considering the distance of these suns from each other, in comparison with the distance of planets from their suns. Our tables of astronomical events, constructed in advance, proceed on the supposition of there being no other system than our own; and they agree with our direct observations, precisely and necessarily. This is our proper field; and we must remember that it is so. We must keep carefully apart the idea of the solar system and that of the universe, and be always assured that our only true interest is in the former. Within this boundary alone is astronomy the supreme and positive science that we have determined it to be; and, in fact, the innumerable stars that are scattered through space serve us scientifically only as providing positions which may be called fixed, with which we may compare the interior movements of our system.

Means of exploration.

We shall find, as we proceed through the whole gradation of the science, that the more complex the science, the more various are the means of exploration; whereas, it does not at all follow, as we shall see, that the completeness of the knowledge obtained is in any proportion to the abundance of our means. Our knowledge of astronomy is more perfect than that of any of the sciences which follow it; yet in none are our means of exploration so few.

The means of exploration are three:—direct observation; observation by experiment; and observation by comparison. In the first case, we look at the phenomenon before our eyes; in the second, we see how it is modified by artificial circumstances to which we have subjected it; and in the third, we contemplate a series of analogous cases, in which the phenomenon is more and more simplified. It is only in the case of organized bodies, whose phenomena are extremely difficult of access, that all the three methods can be employed; and it is evident that in astronomy we can use only the first. Experiment is, of course, impossible; and comparison could take place only if we were familiar with abundance of solar systems, which is equally out of the question. Even simple observation is reduced to the use of one sense,—that of sight alone. And again, even this sense is very little used. Reasoning bears a greater proportion to observation here, than in any science that follows it; and hence its high intellectual dignity. To measure angles and compute times are the only methods by which we can discover the laws of the heavenly bodies; and they are enough. The few incoherent sensations concerned would be, of themselves, very insignificant; they could not teach us the figure of the earth, nor the path of a planet. They are combined and rendered serviceable by long-drawn and complex reasonings; so that we might truly say that the phenomena, however real, are constructed by our understanding.

Its rank.

The simplicity of the phenomena to be studied, and the difficulty of getting at them, constitute, by their combination, the eminently mathematical character of the science of astronomy. On the one hand, the perpetual necessity of deducing from a small number of direct measures, whether angular or horary, quantities which are not themselves immediately observable, renders the use of abstract mathematics indispensable; while, on the other hand, astronomical questions being always, in themselves, problems of geometry, or else of mechanics, must fall into the department of concrete mathematics. Again, the regularity of astronomical forms admits of geometrical treatment; and the simplicity of astronomical movements admits of mechanical treatment with a very high degree of precision. There is perhaps no analytical process, no geometrical or mechanical doctrine, which is not employed in astronomical researches, and many of them have as yet had no other aim. Considering the simple nature of astronomical investigations, and the easy application to them of mathematical means, it is evident why astronomy is, by common consent, placed at the head of the natural sciences. It deserves this place, first, by the perfection of its scientific character; and, next, by the preponderant importance of the laws which it discloses.

Passing over, for the present, its utility in the measurement of time, the exact description of the globe, and the perfecting of navigation, which are not circumstances that could determine its rank, we may just observe that it affords an instance of the necessity of the loftiest scientific speculations to the satisfaction of the most ordinary wants. Hipparchus began to apply astronomical theory to the finding the longitude at sea. A prodigious amount of geometrical science has gone to improve our tables of longitude up to their present point; and if we can not now get within half-a-dozen miles of a true estimate in the seas under the line, it is for want of more science still.

Those who say that science consists in an accumulation of observed facts may here see how imperfect is their account of the matter. The Chaldeans and Egyptians collected facts from observation of the heavens; but there was no astronomical science till the early Greek philosophers referred the diurnal movement to geometrical laws. The aim of astronomical researches was to establish what would be the state of the sky at some future time; and no accumulation of facts could effect this, till the facts were made the basis of reasonings. Till the rising of the sun, or of some star, could be accurately predicted, as to time and place, there was no astronomical science. Its whole progress since has been by introducing more and more certainty and precision into its predictions, and in using smaller and smaller data from direct observation for a more and more distant prevision. No part of natural philosophy manifests more strikingly the truth of the axiom that *all science has prevision for its end:* an axiom which separates science from erudition, which relates the events of the past, without any regard to the future.

When it became a science.

Reduction to a single law.

However impossible may be the aim to reduce the phenomena of the respective sciences to a single law, supreme in each, this should be the aim of philosophers, as it is only the imperfection of our knowledge which prevents its accomplishment. The perfection of a science is in exact proportion to its approach to this consummation; and, according to this test, astronomy distances all other sciences. Supposing it to relate to our solar system alone, the point is attained; for the single general law of gravitation comprehends the whole of its phenomena. It is to this that we must recur when we wish to show what we mean by the *explanation* of a phenomenon, without any inquiry into its first or final cause; and it is here that we learn the true character and conditions of scientific *hypothesis*,—no other science having applied this powerful instrument so extensively or so usefully. After having exhibited these great general properties of astronomical philosophy, I shall apply them to perfect the philosophical character of the other principal sciences.

Regarding astronomical science, apart from its method, and with a view to the natural laws which it discloses, its pre-eminence is no less incontestable. I have always admired, as a stroke of philosophic genius, Newton's title of his treatise on Celestial Mechanics, "The Mathematical Principles of Natural Philosophy;" for it would be impossible to indicate with a more energetic conciseness that the general laws of astronomical phenomena are the basis of all our real knowledge.

Relation to other sciences.

We may see at a glance that astronomy is independent of all the natural sciences, depending on Mathematics alone: and though, philosophically speaking, we put Mathematics at the head of the whole series, we practically regard it less as a natural science of itself (from the paucity of phenomena which it presents to observation) than as the repository of principles by which the natural sciences are interpreted and investigated. Philosophically speaking, astronomy depends on Mathematics alone, owing nothing to Physics, Chemistry, or Physiology, which were either undiscovered, or lost in theological and metaphysical confusion, while astronomy was a true science in the hands of the ancient geometers. But the phenomena of the other sciences are dependent naturally as well as systematically, on astronomical facts, and can be perfectly studied only through astronomy. We can not thoroughly understand any terrestrial phenomenon without considering what our globe is, and what part it bears in the solar system, as its situation and motions affect the conditions of everything upon it; and what would become of our physical, chemical, and physiological ideas, without consideration of the law of gravitation? In the remotest case of all, that of Social phenomena, it is certain that changes in the distance of the earth from the sun, and consequently in the duration of the year, in the obliquity of the ecliptic, etc., which in astronomy would merely modify some coefficients, would largely affect or completely destroy our social development. It is no exaggeration to say that Social physics would be an impossible science, if geometers had not shown us that the perturbations of our solar system can never be more than gradual and restricted oscillations round a mean condition which is invariable. If astronomical conditions were liable to indefinite variations, the human existence which depends upon them could never be reduced to laws.

Not less important is the influence of astronomical science on our own intelligence. It has done much more than relieve us from superstitious terrors and absurd notions about comets and eclipses, —notions which, as Laplace observed, would spring up again immediately if our astronomy were forgotten. This science has done much more for our understandings than that. It has done more than any other pursuit—simply because it is the most scientific of all—to expose and destroy the doctrine of final causes, which is generally regarded by the moderns as the basis of every religious system, though it is in fact a consequence and not a cause. The knowledge of the motion of the earth has overthrown the very foundation of the doctrine, which supposed the universe to be subordinated to our globe, and therefore to Man. Since Newton's time, the development of celestial Mechanics has deprived theological philosophy of its principal intellectual office, by proving that the order maintained throughout our system and the whole universe is by the simple gravitation of its parts. If we took an *à-priori* view, we should say that, as we exist, our system must be such as to admit of our existence; and one necessary condition of this is such a degree of stability in our system as we actually find. This stability we scientifically perceive to be a simple consequence of mechanical laws working among the incidents of our system,—the extremely small planetary bodies in their relation to the larger sun; the small eccentricity of their orbits, and moderate inclination of their planes; which incidents, again, are necessary consequences of the mode of formation of the entire system. The stability by virtue of which we hold our existence is not found in the case of comets, whose perturbations are not only great, but liable to indefinite increase; and their being inhabited is inconceivable. Thus, the doctrine of final causes would be reduced to the truism that there are no inhabited bodies in our system but those which are habitable. This brings us back to the principle of the conditions of existence, which is the true positive transformation of the doctrine of final causes, and of far superior scope and profit in every way.

Divisions of the science.

We have next to consider the divisions of the science. These arise immediately out of the fact, now familiar to us, that astronomical phenomena are either geometrical or mechanical. They are *Celestial Geometry*, which is still called Astronomy, from its having possessed a scientific character before the other; and *Celestial Mechanics*, of which Newton was the immortal founder. Though our business is with our own system, the same division extends to Sidereal astronomy, supposing that kind of exploration to be within our power.

Celestial Geometry.

As before, we see geometry to be more simple in its phenomena than mechanics, and that mechanics is dependent on geometry, without reciprocity. In fact, men were successfully inquiring into the forms and sizes of the heavenly bodies, and studying their geometrical laws, before anything was known of the forces which changed their positions.

Celestial Mechanics.

Whereas, the province of Celestial Mechanics is to analyze the motions of the stars, in order to refer them, by the rules of Rational Mechanics, to the elementary motions regulated by a universal and invariable mathematical law;—thence, again, departing to perfect the knowledge of real motions by scientifically determining them *à priori*, taking from observation the necessary data—the fewest possible—for the calculations of general mechanics. This is the link by which astronomy and physics are connected, and connected so closely that some great phenomena render the transition almost insensible; as in the theory of the Tides. But it is evident that the whole reality of celestial mechanics consists in its having issued from the exact knowledge of true movements, furnished by celestial geometry. It was for want of this point of departure that all attempts before the time of Newton, even Descartes', however valuable in other ways, failed to establish systems of celestial mechanics. This division of the science into two parts has therefore nothing arbitrary in it, nor even scholastic; it is derived from the nature of the science, and is at once historical and dogmatic. As for the subdivisions, we need not trouble ourselves with them now.

In regard to the point of view from which the science should be regarded, Lacaille thought it would simplify matters extremely to place his observer on the surface of the sun. And so it would, if the thing could be done in accordance with positive knowledge; but undoubtedly the solar station should be the ultimate and not the original one, under a rational system of astronomical study. And when, as in the case of this work, the object is the analysis of the scientific method, and the observation of the logical filiation of the leading scientific ideas, it matters less to obtain a clearer exposition of general results than to adhere to the positive method.

I suppose my readers to be well acquainted with the two fundamental facts of the diurnal and annual rotation of our globe, as data without which nothing could be clearly understood of the essential methods and general results of astronomical science. I am not giving a treatise on astronomy, nor even a summary; but a series of philosophical considerations upon the different parts of the science, in which any extended special exposition would be misplaced.

We must first see what methods of observation astronomers need, and are possessed of.

CHAPTER II.

METHODS OF STUDY OF ASTRONOMY.

SECTION I.

INSTRUMENTS.

Observation.

All astronomical observation is, as we have seen, comprehended in the measurement of times and of angles. The two considerations concerned in attaining the great perfection we have reached are the perfecting the instruments, and the application by theory of certain corrections, without which their precision would be misleading.

Shadows.

The observation of shadows was the first resource of astronomers, when the rectilinear propagation of light was established. Solar shadows, and also lunar, were very valuable in the beginning; and much was obtained from the simple device of a style, so fixed as to cast a shadow corresponding with the diurnal rotation to be observed: but the alterations rendered necessary by the annual motion, and impossible to make on that apparatus, rendered the instrument unfit for precise observations. Again, by comparing the length of the shadow cast by a vertical style with the height of the style, the corresponding angular distance of the sun from the zenith was computed: and a valuable method this was: but the penumbra rendered the accurate measurement of the shadow impossible. The difficulty, aggravated by its unequal amount at different distances from the zenith, was partly removed by the use of very large gnomons; but not completely. These imperfections determined astronomers to get rid as soon as possible of the process of gnomonic measurement. Shadows will always be at hand to measure by when better means are wanting: and one application of this instrument remains in our observatories —as the basis of the meridian line, regarded as dividing into two equal parts the angle formed by the horizontal shadows of the same length which correspond to the two equivalent parts of the same day. In this case, the penumbra is harmless, as it affects the two parts equally; and as for the obliquity of the sun's motion, that may be mainly got rid of by choosing the period of either solstice —especially the summer one. It is easy, too, to rectify the observation by the stars.

Proceeding to more exact methods, and, first, with regard to measurement of time, it is clear that the most perfect of all chronometers is the sky. It seems as if it would be enough, after knowing precisely the latitude of one's observatory, to measure the distance of any star from the zenith, and learn its horary angle, and, as an immediate consequence, the time that has elapsed, by resolving the spherical triangle formed by the pole, the zenith, and the star. If a sufficiently wide observation of this kind had been made, and numerical tables formed for certain selected stars, great results might have been obtained from this natural method; but it is insufficient; and it has the defect of making the measure of time depend on that of angles, which is the least perfect of the two, in our day. This method is therefore used only in the absence of a better, as in nautical astronomy; and its commonest service is, in regulating other chronometers, by a comparison with that of the heavens themselves. Artificial methods of measuring time are therefore indispensable in astronomy.

Artificial methods

Every phenomenon which exhibits continuous change might serve, in a rough way, to mark time: various chemical processes, or even the beating of our own pulses, might afford a measure, more or less inaccurate: astronomical phenomena are excluded, because they are what we want to measure: and we therefore have recourse to physical means, and find weight the best. The ancients tried it in the form of the flow of liquids; and the water clocks succeeded the hour-glass; but the uncertainty of these led to solids being preferred; and in the form of weight having a vertical descent. By no care, however, could the disturbances caused by natural forces be remedied, till Galileo, by his creation of rational dynamics, suggested the pendulum. Whether it is or is not correct to assign to Galileo the idea of using the pendulum as a measurer of time, it is certain that his discoveries suggested it, and that Huyghens enabled us to use it. He had recourse to the highest principles of science to render this service, and discovered the principle of vires vivæ, which, besides being scientifically indispensable, afforded to art new means of modifying oscillations without changing the dimensions of the apparatus. Considered as a collection of discoveries for a single aim, Huyghens's treatise *De Horologio oscillatorio*, is perhaps the most remarkable example of special researches that the history of the human mind has yet exhibited. From that time, the perfecting of astronomical clocks became merely a matter of art. In regard to fixed clocks, two things have to be attended to;—the diminution of friction, by improved methods of suspension, and the correction by a compensating apparatus of irregularities caused by variations of temperature. As for portable chronometers, worked by a spiral spring, they are a marvellous invention; but they belong to the province of art, and not science.

The pendulum.

Measurement of angles.

In regard to the measurement of angles, it is clear that an instrument which would admit of an allowance for minutes and seconds, must be of a size incompatible with minute precision. It must always be that large apparatus must be so affected in its weight and temperature as to be impaired in its accuracy. The large telescopes of modern times are intended to show us stars otherwise invisible: and no one thinks of using them for purposes of precise measurement. It is generally agreed now that instruments for measuring angles should not be more than ten feet in diameter when we are dealing with an entire circle; and they are usually not more than six or seven. The wonder then is how we are to estimate angles to a second, as we do every day, with circles whose size would scarcely indicate minutes. It is done by the concurrent use of three methods—the eye-piece, the use of the vernier (so called after its inventor), and the repetition of angles.

It was long before it occurred to astronomers to use their lenses for any other purpose than the discovery of new objects: but at last it occurred to them to replace the ancient transoms and modern sights by an eye-piece which should secure the advantages without the inaccuracies of a large instrument. Morin first made this use of a lens. Auzout followed with his invention of the reticle; and, a century after, Dollond gave us a power of absolute precision by his invention of the achromatic object glass. Vernier proposed in 1631 to divide intervals into parts much more minute than could be marked. He enabled us to ascertain angles, within half a minute, or circles divided only into sixth-parts of a degree. The precision obtainable by his simple apparatus is indefinite, being limited only by our difficulty in detecting the coincidence of the line of the vernier with that of the limb. The union of the third method with these two, gives us the perfection we have attained. It is strange that we should have been so long in perceiving that, the imperfections of angular instruments having nothing to do with the dimensions of the angle to be measured, we should gain much by increasing, in fixed proportions, the magnitude of the angles, which is equivalent to diminishing the imperfection of the instrument. The repetition of angles served every purpose immediately, with regard to terrestrial objects, on account of the steadiness of the point of view; but there was the difficulty, with regard to the heavenly bodies, of their perpetual change of place. Borda applied himself to measure the distance from the zenith of the stars when they crossed the meridian; and the star then remains sensibly at the same distance from the zenith long enough to allow the operation of the multiplication of the angle. By these means, angular instruments are matched with horary in regard to precision. They require from the observer a diligent patience in applying all the minute precautions and rectifications which experience has proved to be indispensable to the fullest use of these instruments.

Then, we have Roemer's meridional eye-glass, which fixes the instant of the passage of a star over the meridian. The plane of the meridian is made in this case purely geometrical, by being described by the optic axis of a simple eye-glass, properly disposed; which is enough when all we want to know is the precise moment of the star's passage. Then there are the micrometrical instruments, by which we measure the diameters of stars, and generally all small angular intervals. These are the material instruments of observation,—horary and angular. We must now advert to the intellectual means,—that is, to the corrections which astronomers must apply to the results exhibited by their instruments. There would be little use in perfecting our instruments, if refraction and parallax introduced as much error into our observation as we had got rid of by the improvement of our apparatus.

Requisite corrections.

The corrections required are of two kinds. The first relate to the errors caused by the position of the observer,—the ordinary refractions and parallax. No deep astronomical knowledge is required for the correction of these. The second class, arising from the same cause, since they proceed from the observer being on a moving planet, are founded on primary astronomical theories: they are the annual parallax, the precession of the equinoxes, aberration, and nutation. Our business now is with the first and most important class.

SECTION II.

REFRACTION.

Refraction.

THE light which comes to us from any star must be more or less turned aside by the action of the terrestrial atmosphere. We must estimate the amount of this deviation before our observations can answer any theoretical purpose. The star is, by this refraction, made to appear too near the zenith, while left in the same vertical plane. Only at the zenith is the error absent, while it increases as the star descends to the horizon. This error, primarily affecting distances from the zenith, must affect, indirectly, all other astronomical measurements, except azimuths: but it would be easy to calculate them, if we once knew the law of diminution and increase of refraction at different distances from the zenith. Philosophers have tried the logical way and the empirical, and have ended by combining the two.

If our atmosphere were homogeneous, the refraction of light would be uniform and calculable. But our atmosphere is composed of strata; and the consequent refractions are excessively unequal, and increasing as the light penetrates a denser stratum, so that its passage constitutes a curve of the last degree of complication. Even this would be calculable, with more or less pains, if we knew the law of variation of these atmospheric densities: but we do not and can not know that law. We have no exact knowledge of the laws of temperature, and can not estimate atmospheric changes, either as to number or degree: and all mathematical processes founded on laws of pressure, etc., may be good as exercises, but are of no value in estimating refraction. As to the empirical method, if the refraction remained always constant at the same height, we might construct tables; and, by extending our observations and instituting various comparisons, we might hope to obtain such a mass of materials as would afford us some certain results. This is what astronomers have, in fact, patiently and laboriously done, by the help of the improved instruments we have spoken of. They have used whatever geometrical help they could make applicable: but the results are discouraging enough. There is nothing like uniformity in the results: for the changes in the atmosphere are beyond our calculation and measurement. We study the barometer, the thermometer, and the hygrometer, at the right moment; we can learn from them only the changes taking place on the spot in which we are; and our tables of refraction vary as our observatories, and even in one observatory at different times. Delambre found differences of four or five minutes between one day and another, after taking all imaginable pains. All that we can do is to confine our observations to the nearest possible approach to the zenith, and to place no reliance on what we attempt near the horizon. By doing this, we shall find our astronomical observations less affected by the unmanageable difficulties of refraction than might be anticipated.

SECTION III.

PARALLAX.

Parallax.

THE difficulty of the parallaxes can be dealt with much more easily and satisfactorily than that of the refractions. Observations of the heavenly bodies made in different places could not be exactly compared without a reference, in idea, to those which would be made from an imaginary observatory, situated in the middle of the earth, which is besides the true centre of apparent diurnal motions. This correction, which is called the parallax, is analogous to that which is constantly made in measurements of the earth's surface, under the more logical name of reduction to the centre of the station.

The effect of the parallax, like that of refraction, is upon the distance of stars from the zenith alone, leaving the star in the same vertical plane, and placing it too far from the zenith, instead of too near, as in the case of refraction. In this instance too, as in the other, though not according to the same law, the deviation increases as the star descends to the horizon. In like manner, too, there must be secondary modifications for all the other astronomical quantities, except with regard to the azimuths. The rectification is easy in comparison with the other case, from the absence of the hopeless difficulties caused by our ill-understood atmosphere. The similar course of the two difficulties, producing counteracting effects, has, we may observe, relaxed the attention of astronomers to the facts of refraction and parallax, by partly concealing their influence on actual observations.

The parallax does not, like refraction, affect all the stars alike, but, on the contrary, affects all unequally, and each according to its position. It is insensible with regard to all which lie outside the limits of our system, on account of their immense distance: and it varies extremely within our system, from the horizontal parallax of Uranus, which can never reach a half-second, to that of the moon, which may at times exceed a degree. Here lies the radical distinction, in astronomical calculations, between the theory of parallaxes and that of refractions. The determination of questions of parallaxes does not wholly depend, like that of refraction, on methods of observation in astronomy, but is truly a portion of science. Depending as it does, ultimately, on the estimate of the distances of the stars from the earth, it pertains to celestial geometry, through the necessity of knowing the law of motion of each star. Thus, it constitutes a part of the science itself; though, in the absence of direct knowledge of the distances of stars, an empirical method of determining the coefficients, analogous to that employed in the case of refraction, may be adopted. The method which will suffice is to choose a place and time which will show the proposed star passing the meridian very near the zenith: then to measure, for several consecutive days, its polar distance, so as to know pretty nearly the amount of this distance at any moment of the process: and this being laid down, then to calculate, for this instant, according to the horary angle and its two sides, the true distance from the star to the zenith, when it is considerably remote from it, without being too near the horizon (say from 75° to 80°): and then, the comparison of this distance with that which is actually observed at the moment, will evidently disclose the corresponding parallax, and therefore the horizontal parallax, provided the due correction for the refraction has been made. This is the method by which it is most easily established that the parallax of all the stars is absolutely insensible.

It is a serious inconvenience in this method, that all the uncertainty of the case of refraction is introduced into that of parallax. In regard to a body whose parallax is very great, as the moon, the uncertainty is of small consequence; but in regard to the sun, or other distant body, an error of one third, or even one half, in the value of its horizontal parallax, might be occasioned. The method is absolutely inapplicable to the remotest of our planets; and not only to Uranus, but to Saturn and Jupiter. The rational method must be resorted to, in the case of these. The empirical method has been mentioned here from the philosophical interest which attaches to the fact that, up to a certain point, the true distances of stars from the earth, at least in proportion to its radius, may be ascertained by observations made in one place; a thing which appears, at first sight, goemetrically impossible.

SECTION IV.

CATALOGUE OF STARS.

Catalogue of stars.

I AM disposed to give a place here, contrary to custom, to the Catalogue of stars, which I think should be reckoned among our necessary means of observation in astronomy. This catalogue is a mathematical table of directions by which we find the different stars. Such a determination is a basis of direct knowledge in regard to Sidereal astronomy: while, in regard to our own system, it is simply a valuable means of observation, which supplies us with terms of comparison indispensable for the study of the interior movements of the system. Such has been the essential use of catalogues of stars, from Hipparchus, who began them, to this day. In order to fulfil their purposes, these catalogues should contain the greatest possible number of stars, spread over every region of the sky. Astronomers have done their duty well; for it is a settled habit with them to determine, as far as they can, the co-ordinates of every new star which they observe; and thus our catalogues are very voluminous, and for ever augmenting. Our business here is not with the system of classification and nomenclature adopted in these catalogues. The nomenclature, bearing as it does the marks of the primitive theological state of astronomy might be easily replaced by one of a methodical character—the objects to be classified heing of the simplest nature, and the distinctions being, in fact, only those of position. But it is this very simplicity which prevents the need from being felt as it would among more complex elements—useful as a rational system would no doubt be in finding and assigning the places of stars. The change will be made in time, no doubt, and the need is not urgent. Stars are not known by their names, for astronomical purposes, but by their descriptions; and the classification and nomenclature in the catalogue, resulting from the fundamental division of the circle, are as perfect as possible; and all else is of little importance. I would only ask that we should cease to speak of the *magnitudes* of stars, as marking their rank, and substitute the word *brightness*, in order to avoid all risk of supposing stars to be large or small in proportion to their brightness or dimness. The word *brightness* would be a simple declaration of the fact, without judging the causes, which we are far from understanding.

By viewing these methods as I have brought them together, we may trace the progress of the science from its earliest days. With regard to angular measurement, for instance, the ancients observed with exactness a degree at the utmost; Tycho Brahe carried up the precision to a minute, and the moderns to a second;—a perfection so recent, that observations which lie more than a century behind our time are considered, from their want of precision, inadmissible in the formation of astronomical theories.

My object has been, chiefly, to show the harmony which exists among these different methods of observation; a harmony which, while it tends to perfect them all, up to a certain point, still restricts them all, by making each a limit to the rest. No improvement in horary or angular instruments, for instance, could carr us far, while our knowledge of refraction remains as imperfect as i is. But there is no reason to suppose that we have approached the limits imposed by the conditions of the subject.

CHAPTER III.

GEOMETRICAL PHENOMENA OF THE HEAVENLY BODIES.

SECTION I.

STATICAL PHENOMENA.

Two classes of phenomena.

THE phenomena of our solar system divide themselves into two classes—the *Statical* and the *Dynamical*. The first class comprehends the circumstances of the star itself, independent of its motions; as its distance, magnitude, form, atmosphere, etc.: the other comprehends the facts of its displacements, and the mathematical considerations belonging to its different positions. According to the usual analogy, the first is independent of the second; while the second could have no existence without the first. The Statical phenomena would exist if the system was immovable: while the dynamical are wholly determined by the statical conditions.

Planetary distances.

The first thing necessary to be known about any heavenly body is its distance from the earth: and the difficulty of obtaining this ground for further observations is extremely great—the smallness of the base of our triangle, and the immensity of the distance of the planet, rendering all accuracy hopeless in very many cases. Toward the middle of the last century, when it was desired to determine the horizontal parallax of the moon—the most manageable of the heavenly bodies—Lacaille went to the Cape of Good Hope, and Lalande to Berlin, to observe its distance at the same moment from the zenith—that moment being appointed—as the middle of an anticipated eclipse. The stations were so chosen as to afford a pretty accurate knowledge of the extent of the line of the base—which was about as long a one as our globe could afford. The observations of the two distances of the moon from the zenith must thus afford the necessary data for the resolution of the triangle which must give the distance sought: and thus we have obtained a very exact knowledge of the moon's distance, which, at its mean, is about sixty terrestrial diameters, and about which we are sure that we can not be mistaken to the extent of more than twelve miles. The same method might serve to give us, though with much less precision, the distance of Venus and even Mars, if the observation was made when they were nearest to the earth; but it becomes too uncertain with regard to the sun. It would leave an uncertainty of at least an eighth, or about twelve millions of miles. Of course, it is of no avail with regard to yet more distant bodies.

The method used by astronomers under this difficulty is to measure, first, distances for which our small terrestrial bases will serve; and on these, according to their related phenomena, to erect other calculations; thus making of the first a basis for the support of new estimates. Aristarchus of Samos conceived of an ingenious method of discovering the distance of the sun through that of the moon; but the uncertainty about seizing the exact moment of the quadrature of the moon introduced fatal inaccuracy into the calculation. Halley's method, by means of the passage of Mercury and Venus over the sun, is more circuitous, and suitable only to an advanced state of geometrical science; but it is far more accurate, and the only one now admissible, for determining the parallax of those planets and of the sun, and therefore the distance of the sun from the earth, through the differences in the transit observable at two very distant stations. By this method we can estimate, within a hundredth part, the distance of the sun from the earth. This distance being ascertained, we have it for a basis for other calculations. We have only to observe the angular distance from the sun to the proposed body, at two periods separated by six months

—that is, from opposite points of the earth's orbit. This gives us an immense triangle, the base of which is twice the length of the distance of the earth from the sun: and thus it is that our knowledge of the earth's motion has helped us to a base twenty-four thousand times longer than the longest that can be conceived on our own globe. It is true, the planet observed will have changed its place in the interval; but the remoter planets—which alone are in question here—move very slowly;—Saturn's circuit, for instance, occupying thirty years; and our times of observation being practically reducible to a shorter time than six months—even to two or one, with regard to those planets of our system which move more rapidly; while the slower ones may be considered almost stationary, during such short periods of time; and again, allowance can be made for this small change of place, according to the geometrical theory of its proper motion. It is in this way that astronomers have attained to their knowledge of the positions of the remotest bodies of our system. The numbers by which we express their relations to the distance of the earth from the sun, are now certain to the third decimal at least.

The vast increase of the basis of observation afforded us by our knowledge of the earth's movement is clearly the greatest that we can attain. If we have cleared the bounds of our globe, we certainly can not go beyond its orbit. Great as this distance appears to us, it vanishes when we want to ascertain the distances of stars outside our system. All measurement is here so out of the question that the most we can do is to fix a limit within which they certainly are not,—saying, for instance, that the nearest star is at least two hundred thousand times more remote than the sun, or ten thousand times further off than the remotest planet of our system; which is quite sufficient to establish the independence of our system.

When we have ascertained the distance of the planets from the earth, it is easy to understand how we may find their distances from each other, since, in the triangle in which each is contained, two sides are already given, and the angle to the earth can always be measured. It is only with regard to the sun and the moon that the distances to the earth are of importance. It is enough to know the distances of the planets from the sun, and of the satellites from their planets, which involve little variation. These are our means for ascertaining astronomical distances. As we might anticipate, our assurance is in proportion to the nearness; and great remoteness baffles us entirely. We see here again, as everywhere, that the most simple and elementary determination depends on the most delicate and complex scientific theories. This first case exhibits so much of the spirit of astronomical procedure, that we may go more rapidly through the other statical heads of celestial geometry.

Form and size.

The distances of the stars from our globe being once ascertained, we can learn whatever we desire about their form and size by observation, if it be but precise enough. Their very distance is favorable to this; for, while their motion or ours displays in turn all their possible aspects, our distance enables us to see at once the whole of each aspect. With regard to the most distant and the smallest, however,—to the stars outside our system, and the satellites of Uranus, and the small planets between Mars and Jupiter,—they can appear to us only as points of vivid light, and their sphericity is concluded upon only through a bold induction. But, in observing the larger planets of our system, we have only to measure their apparent diameter in all directions, after allowing for refraction and parallax. It is much easier to us to learn the form and size of sun and moon than of our own globe, since we have had the aid of glasses. The only case of difficulty is that of Saturn's rings; as it once was with the moon, whose changing aspects greatly puzzled the ancients. The most simple geometry now solves the last difficulty, and Huyghens has helped us over the first. With these exceptions, direct observation assures us that the planets are all round, with more or less flattening at the poles and bulging at the equator, in proportion to the rapidity of their rotation.

As for the size of the heavenly bodies, it is easily calculated from the measurement of the apparent diameter combined with the determination of the distance; and the only reason why men were so long and so widely mistaken about the dimensions of the planets was that their real distances were unknown. No rule as yet appears which connects these results with the order of the distance of the planets from the sun. All we know is that the sun is larger than all the other bodies of the system put together, and in general that the satellites are much smaller than their planets, as the laws of celestial mechanics require. With regard to the bodies outside of our system, as we have no knowledge of their distances, we are, of course, ignorant of their dimensions.

Planetary atmospheres.

It is by the occultation of stars, as starry eclipses are called, that we make observations on the atmospheres of the planets, by seeing what deviation their atmospheres cause in the light of the remote stars which they eclipse. As the sun's light is prolonged to us by the refraction of our atmosphere, the atmosphere of a planet defers (only in a much greater degree) the occultation of the star, and also shortens it; and the comparison of the apparent duration of the eclipse with that which it would otherwise be, gives us data for the calculation of the atmosphere which causes the deviation. It is thus that we learn that the moon has no appreciable atmosphere. The horizontal refraction which, on our globe, would reach thirty-four minutes, does not in the moon amount to a single second. And the inference that an atmosphere is wanting there is confirmed by M. Arago, who in a different path of inquiry, about the polarization of light reflected from liquid surfaces, has established the fact that there are not, on the surface of the moon, any great liquid masses, fitted to form an atmosphere. The next best-known case is that of Venus, which exhibits a horizontal refraction of thirty minutes, twenty four seconds. As for the extent of the atmospheres, it may be roughly conjectured from the cessation of the refracting power; but such conjectures must be very loose, as the refracting power may become imperceptible to us, far within the limits of an atmosphere becoming attenuated toward its verge. The strangest phenomenon is that of the telescopic planets, with the exception of Vesta; the atmosphere of Pallas, for instance, being more than twelve times the diameter of the planet. The usual condition, however, appears to be that shared by our globe,—of an atmosphere which is very shallow in proportion to the dimensions of the planet: and this is nearly all we know.

Earth's form and size.

The remaining statical topic is that of the form and size of the earth, which has been left to the last, on account of its special nature.

Means of discovery.

No glance of the eye will aid us here, not any direct observation whatever. A long accumulation of indirect observations, serving as a basis for complex mathematical reasonings, are our only means. The geometrical aspect of the question must be taken first, though it depends on the highest mechanical theories, and arises from a mechanical beginning. In the infancy of mathematical astronomy, the variations exhibited in different places by the diurnal movement furnished the first geometrical proof of the earth being round. It was enough to establish its evidently and exclusively spherical character, that the change exhibited by the height of the pole on each horizon was always in exact proportion to the length traversed according to any meridian whatever: and this remains the source of all our geometrical knowledge of the form and dimensions of our planet. Astronomers reached their knowledge of its precise form through that of its size; for it was long before its deviation from the perfect spherical form was understood. In this, as in every case, the form of any body is appreciable only by measuring its dimensions in various directions; and here the only difficulty is in the measuring. The first principles of the discovery were given by Eratosthenes, in the early days of the school of Alexandria; but his method was never effectually employed till the middle of the seventeenth century, when Picard undertook to measure the degree between Paris and Amiens. This was the great starting point of the measuring operations, which must have revealed, as they became more perfect, the truth that the earth is not a perfect sphere; but Newton, by his theory of gravitation, and with his one fact of the shortening of the seconds pendulum at Cayenne, settled the matter, by deciding that our globe must necessarily be flattened at the poles, and bulge at the equator, in the relation of 229 to 230. The astronomers could not at once pronounce against the evidence of direct measurement, while the geometers saw the fact to be certain; and the controversy between these two orders of philosophers, for half a century, led to those scientific operations which have brought us all to one mind. The question was settled by the great expedition sent forth, above a century ago, by the French Academy, to measure, at the equator and the pole, the two extreme degrees of latitude which must exhibit the widest variation from each other: and the comparison of these with each other, and with Picard's degree, terminated the controversy, and established, not only the truth of Newton's discovery, but the very near accuracy of his calculation. All the experiments made since, in various countries, have united in confirming the fact of the continual lengthening of degrees in approaching the pole. It does not follow that the figure of the earth has been ascertained with absolute precision. There are slight discrepancies which may either be from imperfection in our estimates, or from the earth not being precisely an ellipsoid of revolution; but whatever may be the results of future labors, we know that we are near enough to the truth for all practical purposes, unless in questions of extreme delicacy. We have no absolute knowledge here, any more than in any other department; and we must be content to make our approximations more complex as new phenomena arise to demand it. Such is the true character of the advances that have been made in this science from the beginning. Superficial observers may call its theories arbitrary, from the incessant changes of view that have arisen: but the knowledge gained has always been positive; every scientific opinion has corresponded with the facts which gave rise to it; and such opinions remain therefore useful and sound at this day, within their own range. The science has thus always exhibited a character of stability, through all incidents of progression, from the earliest days of the Alexandrian school till now.

Such are the statical aspects of the planets of our system. We have now to look at the geometrical theory of their motions.

Planetary motions.

Like all other bodies, the planets have a motion composed of translation and rotation. The connection of these two motions is so natural, that when we know of the one we look for the other. Yet they present very different degrees of difficulty, and require separate consideration.

The progression of the stars was observed long before their rotation,—the unassisted eye being enough for the first; yet the geometrical study of their rotations is easier, because the motions of the observer have no effect upon them; whereas they largely affect questions of translation. And again, the question of orbits is the chief difficulty of the study of translations; and it does not enter into that of rotations. The latter nearly approaches to the character of statical questions; and therefore it ought to be taken first in the exposition of celestial geometry.

Rotation.

Galileo introduced the study of rotations by discovering that of the sun, which was sure to follow closely on the invention of the telescope. The method used is obvious enough, and the same in all cases;—to observe any marks that may exist on the surface of the body, their displacement and return. The more such points of observation are multiplied, the more accurate and complete will be the calculations of time, magnitude, uniformity of movement, etc., deducible from them. There is no more delicate task than this, except with regard to the sun and moon; and none that more absolutely requires a special training of the eye. It is a proof of this, that a careful and honest observer, Bianchini, supposed the rotation of Venus to be twenty-four times slower than it is. Some bodies, as Uranus, are too remote, and others, as the satellites and new planets, too small, to have their rotation established at all, though it is concluded from analogy and induction. We, as yet, know of no law determining the time of these rotations: they are not connected with distances, nor with magnitudes; and they seem only to have some general, but no invariable, connection with the degree of flattening at the poles.* But if the duration is, though regular in each case, altogether irregular as regards the different bodies, the case is much otherwise with the direction; for it is always, throughout our system, from west to east, and on planes slightly inclined to that of the solar equator: and this constitutes an important general datum in the study of our globe.

Translation.

The study of translations, much more complex, is also much more important, if we consider the great end of astronomical pursuit—the exact prevision of the state of the heavens at some future time. Besides that the movement of the earth constitutes an important element in such a study, it must make a difference with regard to other stars, whether the observer is fixed or moving, as his own movement must affect his observation of other motions. We might indeed decide with certainty, without this introductory knowledge, that the sun and not the earth is the true centre of the motions of all the planets, as Tycho Brahe did when he denied our own motion; for it is enough, with this view, to establish that the distances from the planets to the sun scarcely vary at all, while their distance from us varies excessively; and again, that the solar distance between each inferior planet and the sun is less, and between each superior planet and the sun is greater, than our distance from the sun. But we can not go further than this,—we can not determine the form of the planetary orbits, or the mode in which they are traversed, without making a careful and exact allowance for the displacement of the observer. Deferring for the present the subject of the earth's motion, we will briefly notice some important data connected with the planetary motions, which may be obtained without reference to our own movement, and which are so simple as to rank among statical researches. I mean particularly the knowledge of the planes of orbits, and of the duration of the sidereal revolutions, which has nothing to do with the form of the orbits or the variable velocity of the planets. A plane being determined by three points, it is enough to observe three positions of a star to draw a geometrical conclusion about the situation of the plane of its orbit. Astronomers do not now use, in these operations, the declinations and right ascensions, which are the only co-ordinates directly observed, but, for the sake of convenience, two other spherical co-ordinates, improperly called astronomical latitude and longitude, which are analogous, with regard to the ecliptic, to the others with regard to the equator. After having determined the latitude and longitude of the planet in the three positions, its nodes are found; that is, the points at which its orbit meets the plane of the ecliptic, and the inclination of the orbit to this plane. It is evident that confirmation may be obtained by observing other positions of the body, if they are chosen sufficiently remote from each other; and thus we may obtain a far greater precision than in the case of rotations. It is thus that we have learned that the planes of all the planetary orbits pass through the sun; and the same with regard to the satellites of any planet; and that these planes are in general slightly inclined to the ecliptic, and more slightly still to the plane of the solar equator, except the newly-discovered planets, in whose case we find the inclination much more considerable.

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* The rotations of some of the satellites are known. They all follow the law of the moon's rotation, namely, the time corresponds with the orbital periods.—J. P. N.

Sidereal revolution.

The duration of the sidereal revolutions may, of course, be directly observed, in the first instance, by looking for the return of the star to the same spot in relation to the centre of its motion. If we suppose its motion to be uniform, which we may for a first approximation, we can estimate its course by observing the time required between any of the three positions, without waiting for the total revolution, which is sometimes very slow. The geometrical law of this motion permits us to determine, from this kind of observation, the exact time of the planetary revolution. The values of these periodic times are not irregularly divided among the bodies of our system, like the other data that we have noticed. The shorter the course, the more rapid the motion; and the duration increases more rapidly than the corresponding distance; so that the mean velocity diminishes in proportion as the distance increases. We owe to Kepler the discovery of the harmony between these two essential elements, and it is one of the most indispensable bases of celestial mechanics.

Such is the spirit of the methods by which celestial geometry is made to yield us the elementary data which characterize the bodies of the solar system. We have still to consider those of our own planet, before we proceed to the geometrical laws of the planetary motions.

Motion of the Earth.

Evidences of the Earth's Motion.

We are accustomed to think of the motions of translation and rotation as inseparable; but, in the transition from supposing the earth to be motionless, to the present state of our knowledge, a theory existed that it whirled round its axis, but was stationary in space. We now perceive that, in addition to the general evidence of the double motion of the planetary bodies, we have special evidence about our own globe—that the annual motion could not exist without the diurnal, though we might logically suppose beforehand that it could.

As the rotation of the earth can not be absolutely uniform in all parts of its surface, some indications of its course must exist among terrestrial phenomena. We must therefore distinguish between the celestial and terrestrial proofs of our diurnal motion, while the annual motion admits only of the former.

Ancient conceptions.

Immediate appearances go for nothing in this case; for it is clear that, to our eyes (as we do not feel the rotation), it must be exactly the same thing whether we move round among the heavenly bodies, or whether they, fixed in a system, move round us in a contrary direction. There was nothing absurd in the latter supposition, in the old days when men had no doubt of the stars being very near, and not much larger than they appear to the eye, while they exaggerated the size of the earth. They could not avoid supposing that such a mass must be immovable, while the small stars, with their little intervals, were seen moving every day. Even when the Greek astronomers had sketched out the true geometrical theory of the movements of the planets, they treated only of the directions, and had no idea of measuring distances; and it required the whole strength of positive evidence of dimensions and distances to uproot men's strong and natural persuasion of the stability of their globe. From the moment of our obtaining an idea of the proportions of the universe, the old conception became too revolting to reason to be sustained. When it was understood that the earth is a mere point in the midst of prodigious intervals, and that its dimensions are extremely small in comparison with that of the sun, and even of other bodies of our own system, it was absurd to suppose that such a universe could travel round us every day. What velocities would be required to enable the outlying stars to complete such a daily circuit—making allowance for their being twenty-four thousand times nearer the earth, if the earth describes no orbit—and how small the movement of the earth, while those prodigious masses were travelling at such speed! On mechanical grounds, the centrifugal force would be seen to be unmanageable. In every way, the supposition was perceived to be monstrous. Again, the passage of stars before each other, and in a contrary direction to that of the general movement of the sky, showed that they were at different distances from each other, and not bound into an unvarying fabric. Hence arose the notion of Aristotle and Ptolemy, of a system of solid and transparent firmaments. But the existence of comets alone was enough to confute this, appearing as they do in all regions of the sky in turn. As Fontenelle said, this theory put the universe in danger of being fractured. It was, curiously enough, Tycho Brahe, the most illustrious opponent of the Copernican system, who provided for the overthrow of his own arguments by first presenting the true geometrical theory of comets. Long before modern precision was attained, men had been prepared by such

How they gave way.

Earth's rotation.

considerations as the above to conclude upon the rotation of the earth. Long before Copernicus, a rough conception of the truth existed. Even Tycho Brahe felt the astronomical superiority of the true theory; but it seemed to be contradicted by what is before our eyes—the fall of heavy bodies, etc. Copernicus himself could not remove the objections which arose out of men's ignorance of the laws of Mechanics. These objections held their ground for a century, till Galileo established the great law which we have recognised as one of the three on which Rational Mechanics is based—that the relative motions of different bodies are independent of the common motion of the whole. Till this was established, the supposition of the rotation of the earth was inadmissible. It is a curious fact, casting much light upon the action of the human mind, that the opponents of Galileo taunted him with the so-called fact that a ball let down from the top of the mast of a ship in motion would not fall at the foot of the mast, but some way behind—neither they nor anybody else having tried the experiment, which would have shown them that their supposed fact was a mistake. The followers of Copernicus did worse—they admitted the so-called fact, but tried to reason away its bearings with fantastic subtleties. The matter was not settled even by the demonstrations of Galileo, nor till Gassendi compelled observation by a public experiment in the port of Marseilles.

That order of experiments has been carried on, and would be of high value if we could obtain perpendicular stations of sufficient height for the purpose. It is clear that a lofty tower must describe a larger circle in the same time at the top than at the base; and that any body dropped from it must share the higher rate of velocity, having a slight horizontal velocity in the direction of the earth's rotation—falling therefore a little to the east of the base of the tower. Omitting the consideration of the resistance of the air, this amount is calculable in the function of the height of the tower and of its latitude; but experiment would also be valuable; and it is to be hoped that it will be tried at the equator, where the deviation must be greater than anywhere else.

Influence of centrifugal force upon gravity.

The most certain terrestrial proof of the earth's rotation is found by tracing the influence of the centrifugal force upon the direction and intensity of weight. This has been done by that observation of Richer, on the shortening of the seconds-pendulum at Cayenne, which has been mentioned as having emboldened Newton to declare the true figure of the earth. The deviation from the spherical form is too small to account for more than one third of the effect observed; and the other two thirds are precisely what would be required, at the equator, where the centrifugal force is greatest, on the supposition of the earth's rotation. Wherever the delicate observation can be made with sufficient precision on other points of the globe's surface, the result answers to the theory. Thus, we should have sufficient assurance, in the absence of the abundant astronomical proofs that we possess of the rotation of the earth. Probably no one fact has ever, in the history of our race, produced such consequences as that observation of Richer's—two thirds of the estimated effect having completely established the rotation of our globe, and the other third having led Newton to the ascertainment of its form.

Earth's translation.

The movement of translation is ascertainable only by astronomical proofs, for the difference in velocity of the various parts of the globe, in virtue of this motion, is too slight to be sensible to us, or to produce any effect on terrestrial phenomena. When the circuits of other planets were known, men's minds were prepared for that of the earth,—the question then being whether the earth was in analogy with Venus, Mars, Jupiter, etc., or whether, while they continued their courses round the sun, the sun made a yearly circuit round the earth. Reason must declare, in such a case, that any uncertainty must arise simply from the position of the observer, who, placed on any other planet, would have doubted whether he was not the centre of the heavenly motions. Any observation of mere appearances must evidently go for nothing in this case; as appearances must be exactly the same,—the parallelism of its axis of rotation being unaltered,—whether the earth or the sun is in the ecliptic, and the other in the centre. The proofs must be derived from better testimony than mere appearances; and they so abound that we have only to choose among those which are presented by the whole range of the heavens.

Precession of the equinoxes.

The phenomenon called the precession of the equinoxes was observed by Hipparchus, who was struck by the difference of two degrees which he observed between the longitudes of stars in his time and those which had been recorded a century and a half before. To account for such a phenomenon, successive astronomers imagined other heavens; a process that they repeated with regard to nutations, which was a phenomenon too minute for their observation. To account for it, on the supposition of the earth being stable, a third general movement of the whole heavens must be supposed. Newton indicated, and Bradley afterward proved, that very slight alterations in the parallelism of the earth's axis,—such alterations as must result from the influence of the sun, and yet more of the moon, upon the equatorial bulge,—precisely account for the perturbations which create such confusion under the ancient view of the earth's stability. The most unquestionable proof of all, however, is in that class of phenomena called the retrogradations and stations of the planets, which are perfectly explained by the annual circuit of our globe, and are otherwise quite incomprehensible. If two boats are gliding down a river, at different rates of speed, the one must appear to the other advancing, stationary, or retrograde, according as its own speed is smaller, equal, or greater. With regard to the heavenly bodies, their velocities and other circumstances are known to us, so that we can calculate what their courses ought to be to our eyes, on the supposition of our own

Retrogradations and stations of the planets.

annual movement. The appearances answering to our scientific expectation, the proof is practically complete. If the earth moves, the retrogradation of the larger planets ought to happen, as it does, when they are in opposition, and that of Venus and Mercury when they are in inferior conjunction. The regular occurrence of this coincidence was not even attempted to be explained by the ancients.

We have called these proofs practically complete; and they were held to be so by Copernican philosophers before the time of Kepler and Galileo: but our age is not satisfied without a more strict mathematical evidence, amounting to demonstration.

Aberration of light.

The one demonstration on which modern science rests is that derived from the various phenomena of the aberration of light, which are quite incompatible with the stability of the globe. Roemer's observations of the satellites of Jupiter suggested to him the use of light as a measure of distance. Knowing what changes must be taking place at various distances from us in the heavens, and knowing the velocity of light, the variations in time at which the changes become visible to us will be a measure of our change of place and distance. For instance, the first satellite of Jupiter is eclipsed every forty-two hours and a half. The eclipse will take place in a shorter or a longer time than this to our eyes, in proportion as we are removed to the one side or the other of our mean distance from Jupiter, on account of the smaller or greater space that the light will have to travel through. By extending our observation, not only to the other satellites of Jupiter, but to those of Saturn and Uranus, we have obtained further verifications of the relation of our orbit to theirs, and also proof of the uniformity in the passage of light,—at least within our own system. If the earth were immoveable, we might have an error of time, with regard to distant stars, but not of place: but, by compounding the velocity of the earth in its orbit with that of light, which is about ten thousand times greater, we can calculate how far any star ought to appear to deviate from its position. This deviation is found not to exceed, at its *maximum*, twenty seconds in any direction; and therefore forty seconds is the greatest deviation which can appear in the position of any star in the course of the year. It was the striking periodicity of these deviations which led Bradley to seek for the true theory in the combination of the motion of the earth with that of light, and to work it out with the mathematical exactness permitted by modern science; and there is nothing in the case to prevent the direct application of the mathematical process to the visible phenomena. The result is an unquestionable demonstration of the annual movement of the earth, with which all the phenomena of the case precisely agree, and without which they could not exist.

It is evident that this knowledge of aberrations compels us to add another correction to those of refraction and parallax, and the same is the case with regard to the precession of the equinoxes and nutation. Thus, as science advances, the preparation of a phenomenon, observed with the best instruments, for scientific use, becomes a delicate and laborious operation.

Influence of scientific fact upon Opinion.

These are the considerations which have led men to the knowledge of the double motion of the planet we inhabit. No other intellectual revolution has ever so thoroughly asserted the natural rectitude of the human mind, or so well shown the action of positive demonstration upon definitive opinions; for no other has had such obstacles to surmount. A very small number of philosophers, working apart, without any other social superiority than that which attends positive genius and real science, have overthrown, within two centuries, a doctrine as old as our intelligence, directly established upon the plainest and commonest appearances, intimately connected with the whole system of existing opinions, general interests, and dominant authorities, and supported moreover by human pride, powerful in the recesses of each individual mind. The whole system of theological belief rested on the notion that the entire universe was ordained for Man—a notion which appears truly absurd the moment it is seen that our globe is only a subaltern star,—not any centre whatever, but circulating in its place and season, among others, round the sun, whose inhabitants might, with more reason, claim the monopoly of a system which is itself scarcely perceptible in the universe. The notion of final causes and providential laws undergoes dissolution at the same time; for, the once clear and reasonable idea of the subordination of all things to the advantage of Man being exploded, no assignable purpose remains for such providential action. As the admission of the motion of the earth overthrows the whole theory founded on the human destination of the universe, it is no wonder that religious minds revolted from the great disclosure, and that the sacerdotal power maintained a bitter rage against its illustrious discoverer.

The Positive philosophy never destroys a doctrine without instantly substituting a conviction, adequate to the needs of our human nature. If the vanity of Man was grievously humbled when science disabused him of his notion of his supreme importance in the universe, to this vanity at once succeeded a lofty sentiment of his true intellectual dignity, when he saw what means were in his power, under such difficulties as his position imposed upon him, for the discovery of such a truth as he had attained. Laplace has pointed this out, showing how to the fantastic and enervating notion of a universe arranged for Man has succeeded the sound and vivifying conception of Man discovering, by a positive exercise of his intelligence, the general laws of the world, so as to be able to modify them, for his own good, within certain limits. Which is the nobler lot? Which is most in harmony with our highest instincts? Which is the most stimulating to our faculties? And which is the most animating to our feelings?

One more remark suggested by these discoveries is that a clear distinction is for ever established between our system and the universe at large. The old notion of the universe as a single system was founded on the error of the stability of the earth as its centre. The discovery of the earth's revolution at once transported all the external stars to distances infinitely more considerable than the greatest planetary intervals, and has left no place for the idea of system at all, beyond the limits of our sun's influence. We do not know, more or less, and men will probably never know, whether the innumerable suns that we see compose a general system, or any number, large or small, of partial systems entirely independent of each other. The idea of the universe, therefore, is excluded from positive philosophy; and that philosophy is, strictly speaking, bounded by the limits of the solar system, in regard to definite results; and this circumscription is, as elsewhere, to be regarded as real progress. This restriction is further justified by the knowledge we have obtained of all really universal phenomena being essentially independent of the interior phenomena of our system, since the astronomical tables of the state of our system, prepared without reference to any other sun than our own, invariably coincide with the minutest direct observations. The theory of the earth's revolution has not as yet exerted its due influence on our views, and especially in regard to this last consideration. This is doubtless owing to the imperfections of our education, which keep back these high philosophical truths till even the best minds have been possessed with an opposite doctrine: so that the positive knowledge which they afterward attain, commonly does little more than modify and restrain the bad tendencies of their education, instead of ruling and guiding their highest faculties.

Kepler's Laws.

The first idea that occurs to us when we are once satisfied of the revolution of the earth is that our point of view ought henceforth to be the centre of the sun. This transformation of our observation is called the *annual parallax*, and follows the same rules as the diurnal parallax, allowance being made for the much greater distance. Whether our observations of the sidereal heavens are *geocentric* or *heliocentric*—from the middle of the earth or of the sun—is of no appreciable consequence; but within our system the annual parallax is of sensible importance. When, from the central point of view, the orbits of the planets are determined, we can proceed to that great aim and end of the science—the prevision of future conditions of the heavens at appointed times.

Annual parallax.

Circles.

The earliest supposition was that the motions of the planets were uniform and circular. The ancients had a superstition, as their writings abundantly show, that the circle was the most perfect of all forms, and therefore the most suitable for the motion of such divine existences as the stars. The choice of the form was wise: they had to suppose some form, while that of the circle answered best to what they saw; and we ourselves now take it provisionally in forming the theory of a new star. But the superstitious attachment of the ancients to this form was a serious impediment to the advance of astronomy. For every deviation and new appearance a new circle was supposed, till all the simplicity of the original hypothesis was lost in a complication of epicycles. By the end of the sixteenth century the number of circles supposed necessary for the seven stars then known amounted to seventy-four, while Tycho Brahe was discovering more and more planetary movements for which these circles could not account. Thus it is that men cleave to old ideas and methods till they are utterly worn out, and proved beyond recall to be ineffectual, under all additions that can be made to them.

KEPLER.

Then came Kepler, the first man for twenty centuries who had the courage to go back to the beginning, as if nothing had been done in the way of theory. He took for his materials the complete system of exact observations which were the result of the life of his illustrious precursor, Tycho Brahe. Notwithstanding the natural hardihood of his genius, his works reveal to us how strenuously he had to maintain his enthusiasm, in order to support the toils of so bold and difficult an enterprise—rational as it was. He chose the planet Mars for study; and it was a happy choice; because the marked eccentricity of that planet was most apt to suggest the true law of irregularity. Mercury is more eccentric still; but it does not admit of continuous observation. He discovered three great laws, which, extended from the case of Mars to that of all the other planets in our system, constitute the foundation of Celestial Mechanics. The first law regulates the velocity; the second determines the figure of the orbit; the third establishes harmony among all the planetary motions.

His three laws.

First law.

It had long been remarked that the angular velocity (that is, the larger or smaller angle described, in a given time, by its vector radius) of each planet increases constantly in proportion as the body approaches the centre of its motion; but the relation between the distance and the velocity remained wholly unknown. Kepler discovered it by comparing the maximum and minimum of these quantities, by which their relation became more sensible. He found that the angular velocities of Mars at its nearest and furthest distance from the sun were in inverse proportion to the squares of the corresponding distances. Another way of expressing this law is used by himself; that the area described in a given time by the vector radius of the planet is of a constant magnitude, though its form is variable: or, again, in other words, that the areas described increase in proportion to the times. Thus he destroyed the old notion of the uniformity of the planetary motions, and showed that the uniformity was not in the arcs described, but in the areas.

Second law.

The second law was less difficult to discover, when once Kepler had surrendered his attachment to the circle. The next figure that presented itself must naturally be the elipse, which is the simplest form of closed curve, after the circle. The Greek geometers had advanced the abstract theory of this curve some way. Kepler could not long hesitate where to place the sun in it: it must be either in the centre or in one of the two foci. No mathematical labor was needed to show him that it could not be in the centre: and thus, in constructing elliptic orbits, Kepler was necessarily led to place the sun in the focus for all the planets at once. His hypothesis once formed, it was easy to verify it by comparison with observations, the first principles of the required calculations being laid down beforehand. The second law of Kepler, then, is that the planetary orbits are elliptical, having the sun for their common focus.

Third law.

These two laws determined the course of each planet; but the movements of all round their common focus seemed to be purely arbitrary, till Kepler discovered his third law. Being distinguished by the most remarkable genius for analogy ever seen in man, Kepler sought, and successfully, to establish some kind of harmony among all these various movements. He spent much time in pursuing the old metaphysical ideas of certain mystic harmonies which must exist in the universe: but, beyond the general conception of harmony, he obtained no assistance from these vague notions. The ground on which he proceeded was, in fact, the observation of astronomers that the planetary revolutions are always slow in proportion to the extent of their orbits. If he had confined himself to this ground, this discovery would certainly not have occupied seventeen years of assiduous toil. At last his labor issued in the discovery that the squares of the times of the planetary revolutions are proportional to the cubes of their mean distances from the sun: a law which all subsequent observations have verified. One important result of this law is that we may determine the periodic times and mean distances of all the planets by any one. By it, for instance, we have determined the duration of the year of Uranus, when once we knew its distance from the sun; and, conversely, if we discovered a new planet very near the sun, we need only observe its short revolution, to be able to calculate its distance, which, in that position, we could not effect by other means. Astronomers are every day using this double facility, afforded them by Kepler's third law.

These are the three laws which will for ever constitute the basis of celestial geometry, in regard to planetary motions. They answer for all the bodies in our system, regulating the satellites, by placing the origin of areas and the focus of the ellipse in the centre of the respective planets. Since Kepler's time, the number of bodies in our system has more than trebled; and all have in turn verified these laws. By them, motions of translation require for their determination nothing more than a simple geometrical problem, which demands from direct observation only a certain number of data—six for each planet. And thus is a perfectly logical character given to astronomy.

Three problems.

The application of these laws, restricted to our own system, is naturally divided into three problems;—the problem of the planets; that of the satellites; and that of the comets. These are the three general cases of our system; and, by the application to them of Kepler's laws, we may assign to every body within the system, its precise position, in all time past and all time to come; and thence again, we can exhibit all the secondary phenomena, past and future, which must result from such relative positions. The next striking fact of this kind to the general mind is the prediction of eclipses, absolutely conclusive as it is, with regard to the accuracy of our geometrical knowledge. This kind of prediction, quite apart from the vague prophesying of ancient times, when eclipses occurred, as they do now, necessarily from the planetary orbits being all closed curves, and which men's experience told them must return—began in the immortal school of Alexandria; and its degrees of precision, to the hour, then to the minute, then to the second, faithfully represents the great historical phases of the gradual perfecting of celestial geometry. It is this which will, apart from all other considerations, for ever make the observation of eclipses a spectacle as interesting for philosophers as for the public, and on grounds which the spread of the positive spirit will render, we may hope, more and more analogous, though unequally energetic.

Prediction of Eclipses.

We are learning to make more use of this class of phenomena, and to make out new uses from them, as time goes on. Independently of their practical utility in regard to the great problem of the longitudes, they have been found, within a century, very important in determining with more exactitude the distance of the sun from our earth. Whether it be an eclipse by the moon, or the transit of Venus or Mercury, the difference in duration of the phenomenon, observed in different parts of the earth, will furnish the relative parallax of that body and the sun, and consequently the distance of the sun itself. Some bodies are more fit than others for this experiment, certain conditions being necessary, which are not common to all. Of the three known bodies which can pass between us and the sun, two—the Moon and Mercury—are excluded by these conditions; and there remains only Venus. Halley taught us how to conduct and use the observation. The parallax, in such a position, offers suitable proportions, being nearly three times that of the sun; and the angular velocity is small enough to allow the phenomenon (lasting from six to eight hours) to present differences of at least twenty minutes between well-chosen observatories. I have specified this case, on account of its extreme importance to the whole system of astronomical science; but it would be quitting our object and plan to notice any other secondary cases.

Transit of Venus.

I must remark upon one very striking truth which becomes apparent during the pursuit of astronomical science;—its distinct and ever-increasing opposition as it attains a higher perfection to the theological and metaphysical spirit. Theological philosophy supposes everything to be governed by will; and that phenomena are therefore eminently variable and irregular,—at least virtually. The Positive philosophy, on the contrary, conceives of them as subjected to invariable laws, which permit us to predict with absolute precision. The radical incompatibility of these two views is nowhere more marked than in regard to the phenomena of the heavens; since, in that direction, our prevision is proved to be perfect. The punctual arrival of comets and eclipses, with all their train of minute incidents, exactly foretold, long before, by the aid of ascertained laws, must lead the common mind to feel that such events must be free from the control of any will, which could not be will if it was thus subordinated to our astronomical decisions.

Foundation of Celestial Mechanics.

The three laws of Kepler form the foundation of the higher conception to which we are next to pass on; the mechanical theory of astronomical phenomena. By this ulterior study, we obtain new determinations; but a more important office of the Mechanical theory is to perfect celestial geometry itself, by giving more precision to its theories, and establishing a sublime connection among all the parts of our solar system, without exception. The laws of Kepler, inestimable as they are, have come to be regarded as a sort of approximation,—supposing, as they do, various elements to be constant, while they are subject to more or less alteration. The exact knowledge of the laws of these variations constitutes the principal astronomical result of celestial mechanics, independently of its own high philosophical importance.

SECTION II.

DYNAMICAL PHENOMENA.

Gravitation.

Character of laws of Motion

The laws of Motion, more difficult to discover than those of extension, and later in being discovered, are quite as certain, universal, and positive in character: and of course it is the same with their application. Every curvilinear displacement of any kind of body,—of a star as well as a cannon-ball,—may be studied under the two points of view which are equally mathematical: geometrically, in determining by direct observation the form of the trajectory and the law by which its velocity varies, as Kepler did with the heavenly bodies; and mechanically, by seeking the law of motion which prevents the body from pursuing its natural straight course, and which, combined with its actual velocity, makes it describe its trajectory, which may henceforth be known *à priori*. These inquiries are evidently equally positive, and in like manner founded upon phenomena. If we find still in use some terms which seem to relate to the nature and cause of motion, they are only vestiges of a mode of thinking long gone by; and they do not affect the positive character of the research.

The two motions which constitute the course of the cannon-ball are perfectly known to us beforehand; but we have not the geometrical knowledge of its trajectory. With regard to the star, our knowledge of its trajectory compensates exactly for the difficulty of our preliminary ignorance about its elementary motions. If the law of the fall of weights had not been directly established, we should have learned it, indirectly, but no less surely, from the observation of the curvilinear motions produced by weight.

Their History.

Celestial Mechanics was then founded on a firm basis, when through Kepler's laws, and by the rules of rational Dynamics, discovery was made of the law of direction and intensity of the force which must act upon the planet to divert it from the tangent which it would naturally describe. This fundamental law once discovered, all astronomical researches enter into the domain of Mechanics, in which the motions of bodies are calculated from the forces which impel them. This was the course philosophically and perseveringly pursued by Newton.

It does not detract from Newton's merits that Kepler had some foresight of the results of his great laws. He carried their dynamic interpretation as far as the science of his day permitted; and, seeking for what could not yet be found, he wandered off among fantasies. The true precursors of Newton, as founders of dynamics, were Huyghens and Galileo,—especially the last: yet history tells of no such succession of philosophical efforts as in the case of Kepler, who, after constituting celestial geometry, strove to pursue that science of celestial mechanics which was, by its nature, reserved for a future generation. As the means were wanting, he failed; but the example is not the less remarkable.

The first of Kepler's laws proves that the accelerating force of each planet is constantly directed toward the sun. The accelerating force, however great it may be supposed, does not at all affect the magnitude of the area which would be described in a given time by the vector radius of the planet, in virtue of its velocity, if its direction passes exactly through the sun, while it would inevitably change it on any other supposition. Thus, the permanence of this area,—the first general datum of observation,—discloses the law of direction. The great difficulty of the problem, gloriously solved by Newton, lies in the discovery, by means of Kepler's other two theorems, of the law of the intensity of this action, which we speak of as exercised by the sun on the planets.

When Newton began to work on this conception, he took Kepler's third law as his basis, supposing the orbits, as he might do for such a purpose, to be circular and uniform. The solar action, equal, and opposed to the centrifugal force of the planet, thus became necessarily constant at the different points of the orbit, and could not vary but in passing from one planet to another. This variation between one planet and another was provided for by the theorems of

Huyghens relating to the centrifugal force in the circle. This force being in proportion to the relation between the radius of the orbit and the square of the periodic time, must vary from one star to another inversely to the square of its distance from the sun, in virtue of the permanence which Kepler showed to exist of the relation between the cube of this distance and this same square of the periodic time, for all the planets. It was this mathematical consideration which put Newton in the way of his great discovery, and not any metaphysical reasonings, such as prevailed before it, and which probably never entered his mind, one way or another.

Newton's demonstration.

There remained the difficulty of explaining how this law of the variation of the solar action agreed with the geometrical nature of the orbits, as exhibited by Kepler. The elliptical orbit presented two remarkable points,—the aphelion and the perihelion, in which the centrifugal force was directly opposed to the action of the sun, and consequently equal to it; and the change in this action there must be at the same time more marked. The curve of the orbit was evidently identical at these two points; the action then had simply to be measured, according to Huyghens' theorems, by the square of the corresponding velocity. Thence, it was easily deduced, from Kepler's first law, that the decrease of the solar action, from the perihelion to the aphelion, must be inversely to the square of the distance. Here was a full confirmation of the law which related to the different planets by an exact comparison between the two principal positions of each of them. Still, however, the elliptical motion had not been considered. Any other curve would, thus far, have served as well as the ellipse, provided its two extremities had shown an equal curvature. The remaining portion of the demonstration,—the measurement of the solar action throughout the extent of the orbit,—is to be obtained only by transcendental analysis. The process is necessary for carrying on the comparison of the solar action and the centrifugal force; and the theory of the curvature of the ellipse is required. Huyghens made a near approach to the principle of this great process; but it could not be completed without the aid of the differential analysis, of which Newton was the inventor, as well as Leibnitz. By the aid of this analysis, the force of the solar action in all parts of the orbit is easily estimated, in various ways; and it is found to vary inversely to the square of the distance, and that it is independent of the direction. Furthermore, the same method shows, in accordance with Kepler's third law, that the action varies in proportion to distance alone: so that the sun acts upon all the planets alike, whatever may be their dimensions, their distance only being the circumstance to be considered. Thus Newton completed his demonstration of the fundamental law that the solar action is, in every case, proportionate, at the same distance, to the mass of the planet; in the same way that, by the identity of the fall of all terrestrial bodies in a vacuum, or by the precise coincidence of their oscillations, proof had already been obtained of the proportion between their weight and their masses. We thus see how the three laws of Kepler have concurred in establishing, according to the rules of rational mechanics, this fundamental law of nature. The first shows the tendency of all the planets toward the sun; the second shows that this tendency, the same in every direction, changes with the distance from the sun, inversely to its square; and the third teaches that this action is always simply proportionate, the distance being equal, to the mass of each planet. In accordance with the laws of Kepler, which relate to the whole interior of our system, the same theory applies to the connection between the satellites and their planets.

Newton thought it necessary to complete his demonstration by presenting it in an inverse manner; that is, by determining *à priori* the planetary motions which must result from such a dynamic law. The process brought him back, as it must do, to Kepler's laws. Besides furnishing some means of simplifying the study of these motions, this labor proved that, whereas, by Kepler's laws, the orbit might have had more figures than one, the ellipse was the only one possible under the Newtonian law.

Old difficulty explained.

It was once a great perplexity to some people, which others could not satisfactorily explain, that when the planet is travelling toward its aphelion we can not say that it tends toward the sun. But the difficulty arose out of the use of inappropriate language. The question is, not whether the planet is nearer to the sun than it lately was, but whether it is nearer than it would have been without the force that sends it forward. It is always tending toward the sun to the utmost that is allowed by the other force to which it is subjected. The orbit is always concave toward the sun; and it would evidently have been insurmountable if the trajectory could have been convex. In the same way, when a bomb ascends, its weight is not suspended or reversed: it always tends toward the earth, and is, in fact, falling toward it more rapidly every moment, even if ascending, because it is every moment farther below the point at which it would have been but for the action of the earth upon it; and its trajectory is always concave to the ground.

Term *Attraction* inadmissible.

I have thus far carefully avoided giving any name to the tendency of the planets toward the sun, and of the satellites toward the planets. To call it *attraction* would be misleading; and we, in truth, can know nothing of its nature. All that we know is that these bodies are connected, and that their effect upon each other is mathematically calculable. It is by quite another property of Newton's great discovery that this effect is *explained*, in the true sense of the word,—that is, comprehended from its conformity with the ordinary phenomena which gravity continually produces on the surface of our globe. Let us now see what this property of the discovery is.

We owe a great deal to the moon. If the earth had no satellite, we might calculate the celestial motions by the rules of dynamics, but we could not connect them with those which are under our immediate observation. It is the moon which affords this connection by enabling us to establish the identity of its tendency toward the earth with weight, properly so called: and from this knowledge, we have risen to the view that the mutual action of the heavenly bodies is nothing else than weight properly generalized: or, putting it the other way, that weight is only a particular case of the general action. The case of the moon is susceptible of the most precise testing. The data are known; and by dynamical analysis, the intensity of the action of the earth upon the moon is exactly ascertainable. We have only to suppose the moon close to the earth, with the due increase of this intensity, inversely to the square of the distance, and compare it with the intensity of weight on the earth, as manifest to us by the fall of bodies, or by the pendulum. A coincidence between the two amounts to proof; and we have, in fact, mathematical demonstration of it. It was in pursuing this method of proof that Newton evinced that philosophical severity which we find so interesting in the anecdote of his long delay, because he could not establish the coincidence, while confident that he had discovered the fact. He failed for want of an accurate measurement of a degree on the earth's surface; and he put aside this important part of his great conception till Picard's measurement of the earth enabled him to establish his demonstration.

Extent of the demonstration.

The identity of weight and the moon's tendency toward the earth places the whole of celestial mechanics in a new light. It shows us the motions of the stars as exactly like that of projectiles which we have under our immediate observation. If we could start our projectiles with a sufficient and continuous force, we should, except for the resistance of the air, find them the models of the planetary system: or, in other words, astronomy has become to us an artillery problem, simplified by the absence of a resisting medium, but complicated by the variety and plurality of weights.—If our observation of weight on our globe has helped us to a knowledge of planetary relations, our celestial observations have in turn taught us the law of the variation of weight, imperceptible in terrestrial phenomena. Men had always conceived weight to be an inalterable property of bodies, finding that no metamorphosis,—not even from life to death,—made any change in the weight of a body, while it remained entire. This was the one particular in which men might suppose they had found the Absolute. In a moment, the Newtonian demonstration overthrew this fast-rooted notion, and showed that weight was a relative quality,—not under the circumstances in which it had hitherto been observed, but under the new one,—the position of the observed body in the system,—its distance from the centre of the earth. The human mind could hardly have sought out this fact directly: but, once revealed in the course of astronomical study, the verification easily followed; and experiments on our own globe, in the vertical direction, and yet more in the horizontal, have established the reality of the law, by experiments too delicate, from the necessity of the case, to be appreciable, if we had not known beforehand what differences must be found to exist.

Term *Gravitation* unobjectionable.

It is to express briefly the identity between weight and the accelerating force of the planets that the happy term *Gravitation* has been devised. This term has every merit. It expresses a simple fact, without any reference to the nature or cause of this universal action. It affords the only explanation which positive science admits; that is, the connection between certain less known facts and other better known facts. Since the creation of this term, there has been no excuse for the continued use of the word *attraction*. It is desirable to avoid pedantry in language; but it is of high importance to preserve pure the positive character of so fundamental a conception as this, by using a term which expresses exactly what we know, and dismissing one which assumes what is purely fanciful, and wholly incorrect. Attraction is *a drawing toward*. Now, when we draw anything toward us, the distance is of no importance: the same force draws the same body with equal ease three feet or thirty feet, which is directly contradictory to the facts of gravitation. Our business is with the fact of the action, and not at all with its nature. It was the use of this metaphysical term, it now appears, which occasioned the opposition that the Newtonian theory encountered so long, and especially in France. Descartes had, by laborious efforts, banished the notions of occult qualities, which he perceived to be so fatal to science; and in this theory of attraction, his followers saw a falling back into the old metaphysical delusions. We perceive this in the writings of John Bernouilli and Fontenelle: and it appears that the clear and positive scientific intellect of France did good service in stripping off from the sublime discovery of Newton the metaphysical appearance which obscured its reality for a time.

Gravitation is that of molecules.

One more consideration remains to be adverted to. We have regarded the heavenly bodies thus far as points, without reference to their forms and dimensions. But as it is proved that the intensity of the action of the sun on the planets, and of the planets on their satellites, is proportioned to the mass of the body acted upon, it is clear that the force operates directly only on molecules, which are all independently affected by it; and equally, their distance being the same. The gravitation of molecules is therefore the only real one; and that of masses is simply its mathematical result. In the mathematical study of motions, however, it is necessary to have a conception of a single force, instead of such an infinity of elementary actions: and hence arises that preliminary part of celestial mechanics which consists in compounding in one result all the mutual gravitation of the molecules of two stars. Newton founded this portion, with all the rest; and the two theorems which he established for the purpose still remain the commonest expression of this important theory.

He proved that if the stars were truly spherical, and their strata were homogeneous, the gravitation of their particles would be so balanced that the bodies might be treated as points, in the study of their motions of translation. But the irregularity of their forms, however slight, must be considered in the theory of their rotations, to which these theorems cease to be applicable. For any other form than the sphere, the problem becomes very complicated; and the analytical difficulties can be surmounted only by approximation, notwithstanding all the perfections introduced into the theory in recent times. And unless we could also learn what is the law of density in the interior of the stars,—a kind of knowledge which seems to be for ever beyond our reach,—we can not attain a perfect solution.

Secondary gravitation.

The fundamental law of Rational Mechanics, which declares the necessary equality of action and reaction, shows that gravitation must be mutual,—that the sun must tend toward the planets, and the planets toward their satellites. The extreme inequality of the masses renders the ascertainment of the inverse gravitation extremely difficult; yet its reality is established by various secondary phenomena. The gravitation of the planets toward each other is a necessary part of the whole conception; but it was not mathematically demonstrated till Newton's successors deduced from it an exact explanation of the perturbations observed in the principal motions of the planets. Their labors have established secondary gravitation as positively as the primary.

Thus has every kind of proof concurred to establish that great fundamental law which is the noblest result of our aggregate studies of nature. All the molecules of our system gravitate toward each other, in proportion to their masses, and inversely to the squares of their distances.

Domain of the law.

I dare not, as many do, confidently extend the application of this law to the entire universe. There can be no objection to entertaining it analogically till we obtain some knowledge of the mechanism of the sidereal heavens; but we must remember that we have not yet that knowledge, and that we can not promise ourselves that we ever shall. Without the phenomena of our own system, the theory of its motions would be only an intellectual exercise and sport: there can be no positive science apart from phenomena, and of the phenomena of the universe beyond our own system we are not in scientific possession.* It must be understood that I advocate simply a suspension of judgment where there is no ground for either affirmation or denial. I merely desire to keep in view that all our positive knowledge is relative; and, in my dread of our resting in notions of anything absolute, I would venture to say that I can conceive of such a thing as even our theory of gravitation being hereafter superseded. I do not think it probable; and the fact will ever remain that it answers completely to our present needs. It sustains us, up to the last point of precision that we can attain. If a future generation should reach a greater, and feel, in consequence, a need to construct a new law of gravitation, it will be as true as it now is that the Newtonian theory is, in the midst of inevitable variations, stable enough to give steadiness and confidence to our understandings. It will appear hereafter how inestimable this theory is in the interpretation of the phenomena of the interior of our system. We already see how much we owe to it, apart from all specific knowledge which it has given us, in the advancement of our philosophical progress, and of the general education of human reason. Descartes could not rise to a mechanical conception of general phenomena without occupying himself with a baseless hypothesis about their mode of production. This was, doubtless, a necessary process of transition from the old notions of the absolute to the positive view; but too long a continuance in this stage would have seriously impeded human progress. The Newtonian discovery set us forward in the true positive direction. It retains Descartes' fundamental idea of a Mechanism, but casts aside all inquiry into its origin and mode of production. It shows practically how, without attempting to penetrate into the essence of phenomena, we may connect and assimilate them, so as to attain, with precision and certainty, the true end of our studies,—that exact prevision of events which *à-priori* conceptions are necessarily unable to supply.

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* M. Comte omits here all notice of such positive applications as we are able to make in Sidereal astronomy. He takes no notice of the fact that the motion of the multiple stars in elliptical orbits, and in accordance with Kepler's law of the velocities, demonstrates the existence of a law of force, according to the inverse square of the distance. —J. P. N.

CHAPTER IV.

CELESTIAL STATICS.

Consummation by Newton.

KEPLER'S laws connected celestial phenomena to a certain degree, before Newton's theory was propounded: but they left this imperfection,—that phenomena which ranked under two of these laws had no necessary connection with each other. Newton brought under one head all the three classes of general facts, uniting them in one more general still; and since that time we have been able to perceive exactly the relation between any two of the phenomena which are all connected with the common theory. As far as we can see, there is nothing more to gain in this direction.

Statical considerations.

We have seen what this great conception is in itself. We have now to observe its application to the mathematical explanation of celestial phenomena, and the perfecting of their study. For this purpose, we will recur to our former division of subjects, and contemplate the phenomena of planets as immoveable first, and of planets in motion afterward; the statical phenomena first, and the dynamical afterward.

To know the mutual gravitation of the heavenly bodies, we must know their masses. Such knowledge once appeared inaccessible from its very nature; but the Newtonian theory has put it within our power, and furnished us with a wholly new set of ideas about these bodies. There are three ways in which the inquiry has been prosecuted, all differing from each other, both in generality and in simplicity. The first method, the most general, the only one in fact which is applicable to all cases, is the most difficult. It consists in analyzing the special share of each body in the perturbations observed in the principal motions of another,—both of translation and rotation. Here two elements are concerned,—the distance, and the mass of the star in question. The first is well known, the other is not; and only an approximate determination is possible. It is difficult to apportion the shares in the action; and geometers place little dependence on the computation of masses obtained by this method, in comparison with that obtained by either of the others.

First method of inquiry into masses.

Second method.

Nearest in generality to this first method is that which Newton employed with regard to planets that had a satellite; that of comparing the motion of the satellite round the planet with that of the planet round the sun. The law which determines the action by the distance being compared, in its results, in the two cases, gives the relation of the masses of the sun and the planet. The mass of Jupiter, determined by Newton in this way, has undergone little change of statement by methods since employed; and what difference there is is almost wholly owing to the data of the process being now better known.

Third method.

The third method is the most direct and simple of all; but it is the most restricted, as it is necessarily confined to the planet inhabited by the observer. It consists in estimating the relative masses by the comparison of the weights which they produce. If we knew the mass of any planet, we should know what would be the weight of things on its surface, or at a given distance; and reciprocally, the weight being known, we are able to estimate the mass. With the pendulum we have measured terrestrial weight with absolute precision; and, diminishing it, inversely to the square of the distance, we shall know its value at the distance of the sun. We have then only to compare it with the amount, before well known, which expresses the sun's action upon the earth, to find immediately the relation of the mass of the earth to that of the sun. With regard to every other planet, on the contrary, it must be the estimate of its mass which would yield that of its corresponding gravity. All these methods being practicable in the case of the earth, its mass, in comparison with that of the sun, must be considered the best known of all within our system. The mass of the moon, and that of Jupiter, are now estimated almost as perfectly; and those of Saturn and Uranus come next. We are less sure about the other three which have been calculated—Mercury, Venus, and Mars; though the uncertainty about them can not be very great. Of the telescopic planets and the comets we know scarcely anything, owing to their extreme smallness, which precludes their exerting any sensible influence on perturbations. Comets pass, during their prodigious course, near very small stars, such as the satellites of Jupiter and Saturn, without producing any perceptible derangement. As for the satellites, we have no knowledge except of the moon, and approximately, of those of Jupiter. No comparison of results has as yet exhibited any harmony whatever between them. The only essential circumstance which they present is the vast superiority of the size of the sun to the whole contents of the system. Those entire contents, if thrown together, would scarcely amount to a thousandth part of the mass of the sun. Looking abroad from the sun, we see alternating, without any visible order, here decreasing, there increasing masses. We might have supposed, *à priori*, as Kepler did, that the masses were regularly connected with the volumes (which are themselves irregular, however), so that the mean densities should be continually less in mathematical proportion to their distances from the sun. But, independently of this numerical law, which is never exactly observed, the simple fact of the decrease of density presents some exceptions, in regard to Uranus, among others. No rational ground can be assigned for this.

SECTION I.

WEIGHT OF THE EARTH.

Weight of the earth.

THESE are the means by which the masses of the bodies of our system are ascertained. The remaining process is to bring them into relation with our estimates of weight by ascertaining the total weight of the earth. Bouguer was the first who distinctly perceived the possibility of such an estimate, during his scientific expedition to Peru, when he found that the neighborhood of vast mountains slightly affected the direction of weight. We see how, in accordance with the law of gravitation, a considerable mass, regarded as condensed in its centre of gravity, may affect the plumb-line, however slightly, if it be brought close enough, subjecting it to a secondary gravitation, which affords data for a comparison between the action of the earth and that of the mountain. By this, some estimate may be formed of the proportion of the mountain to the globe. In the time of Bouguer science was not advanced enough to admit of more than the conception of how the thing could be done. Half a century later, Maskelyne observed the mountain Schehallion in Scotland, and found that it occasioned an alteration in the natural direction of weight of from five to six seconds; and Hutton deduced from this that the weight of the earth is equal to four and a half times that of a similar volume of distilled water at its maximum of density. Anything like exactness, however, is out of the question while there must be so much uncertainty about the weight of the mountain, which can be calculated only from its volume.

When Coulumb had invented his Torsion Balance, intended to measure the smallest forces, Cavendish saw how the earth might be weighed by comparing it, by means of this balance, with artificial masses which might be computed. By his immortal experiment, he discovered the mean density of our globe to be five and a half times equal to that of water; whence we can, if we think proper, deduce the weight of the earth in cwts. and tons.—We thus obtain, among other advantages, some insight into the constitution of our globe, which by its positivity, puts to flight many fanciful notions. The density of the parts near the surface is so far below the average—water occupying much space, for instance—that the density nearer the centre must be much above the average. This is in accordance with the indications of Celestial Mechanics; and it furnishes us with one condition of the interior of the globe. There can be no void there. What there is we know not, further than that it must be something consistent with the condition of superior density.

SECTION II.

FORM OF THE PLANETS.

Form of the planets.

THE next great statical inquiry relates to the form ot the heavenly bodies, as deduced from the theory of their equilibrium.

Geometers suppose the planetary bodies to have been originally fluid, because their equilibrium can thus consist with only one form; whereas, if they had been always solid, as our earth is now, their equilibrium might have been compatible with any form whatever. Several phenomena indicate this supposition, and it agrees remarkbly with the whole of our direct observations.

Difficulty of the inquiry.

If the planets had no motion of rotation, their being perfectly spherical would accord with the equilibrium of their molecules: but the centrifugal force engendered by the rotation must necessarily modify the primitive form, by altering, more or less, the direction, or the intensity of weight, properly so called. Huyghens established this with regard to the direction, and Newton with regard to the intensity. We thus become easily assured of the general fact of the nearly spherical form of all the planets, and of their being slightly flattened at the poles: but, when we go further, and attempt to estimate their forms mathematically, and learn the precise degree of the flattening at the poles, the question becomes one of transcendental analysis, and is involved in difficulty which can never be entirely surmounted. The inquiry involves a sort of vicious circle, which does not admit of a logical issue. In order to form an equation of the surface, we ought, by the law of equilibrium of fluids, to know the weight of the molecules concerned; whereas, by the law of grav

Geometrical estimate.

itation, this can be ascertained only through the knowledge of the form of the planet, and even of the mode of variation of its interior density. All that can be done is to discover whether the proposed form fulfils such and such conditions. Maclaurin discovered a theorem, highly valued by geometers, which has become the basis of all our inquiries on this subject, and which shows that the ellipsoid of revolution precisely fulfils the conditions of equilibrium. But this supposes the structure of the body to be homogeneous; which it is not, in any case. The labors of geometers have however brought within very narrow limits the possible variations of the polar flattening. The result with regard to the earth is that the mathematical rule perfectly agrees with direct observation.

Estimate from perturbations.

In the case of the planets we have another resource Their flattening affects certain phenomena of perturbation, by the study of which we obtain materials for an estimate. Altogether, the calculations and measurements agree more closely than we could have ventured to hope. The only case which seems to present a real exception is that of Mars, which, by its magnitude, its mass, and the time of its rotation, should be little more flattened than the earth; whereas, if the observations of Herschel are exact, it is almost as much so as Jupiter.—We must observe, moreover, that though, as Maclaurin has shown, equilibrium is compatible with the ellipsoid form, this form is not to be supposed the only one:—witness, in our own system, the rings of Saturn, which are a remarkable example to the contrary: and Laplace has demonstrated how these rings could, even in a fluid state, be in equilibrium.

Indirect estimate of the earth's form.

The most useful consequence of the mathematical theory of the planetary forms is that it has established an important relation between the value of the different degrees on the earth's surface and the intensity of the corresponding gravity, measured by the length of the seconds pendulum in different latitudes. We can thus, with great ease multiply our indirect observations about the form of our globe; whereas the geometrical estimate of degrees is a long and laborious operation, which can not be often repeated with due care. But, generally speaking, the more indirect a measurement is, *cæteris paribus*, the more uncertain it is: and there remains the uncertainty arising from our ignorance of the law of interior density in our earth; so that our chief reliance should still be on mathematical measurement, conducted with due care.

Hydrostatic theory of planetary forms.

An interesting question belonging to the hydrostatic theory of the planetary forms is of the conditions of stability of equilibrium of the fluids which are collected on a part or the whole of the surface of the planets. Laplace shows this stability to depend, under all circumstances, on the density of the fluid being less than the mean density of the planet; a view established with regard to the earth by Cavendish's fine experiment.

SECTION III.

THE TIDES.

THERE remains the question of the tides—the last important inquiry under the head of celestial statics. Under the astronomical point of view, this is evidently a statical question—the earth being, in that view, regarded as motionless; and it is not less a statical question in a mathematical view, because what we are looking at is the figure of the ocean during periods of equilibrium, without thinking of the motions which produced that equilibrium. Moreover, this inquiry naturally belongs to the study of the planetary forms.

Question of the tides.

A particular interest attaches to this question, from its being the link between celestial and terrestrial physics—the celestial explanation of a great terrestrial phenomenon. Descartes did much for us in establishing this. He failed to explain the phenomenon; but he cast aside the metaphysical conceptions which had prevailed before, and showed that there was a connection between the change of the tides and the motions of the moon; and this certainly helped to put Newton in the way of the true theory. As soon as it was known that the cause of the tides was to be looked for in the sky, the theory of gravitation was certain to afford its true explanation. Newton, therefore, gave out the simple principle that the unequal gravitation of the different parts of the ocean toward any one of the bodies of our system, and particularly toward the sun and moon, was the cause of the tides; and Daniel Bernouilli afterward perfected the theory. The same theory answers for the atmosphere; but we had better study it in the case of the seas alone; on account of the uncertainty of our knowledge of the vast gaseous covering of our globe, whose diffused mass almost defies precise observation.

Theory of the tides.

Suppose the earth joined to any heavenly body by a line passing through the earth's centre. It is clear that the point of the earth's surface which is nearest the other body will gravitate toward it more, and the remoter point less, than the centre, inversely to the squares of their respective distances. The first point tends away from the centre: and the centre tends away from the second point; and in each case the fluid surface must rise; and in nearly the same degree in both cases. The effect must diminish in proportion to the distance from these points in any direction: and at a distance of ninety degrees it ceases. But there the level of the waters must be lowered because of the exhaustion in that place caused by the overflow elsewhere. And here enters a new consideration, difficult to manage:—the changes in the terrestrial gravity of the waters, occasioned by their changes of level. Thus the action of any heavenly body causes the ocean to assume the form of a spheroid, elongating it in the direction of that body. Newton calculated the chief part of the phenomenon of the tides on the supposition of an ellipsoid of homogeneous structure, as he had done in estimating the effect of the centrifugal force on the earth's figure, substituting for the centrifugal force the difference between the gravitation of the centre of the globe and that of its surface next the proposed body. After that, Maclaurin's theorem served Daniel Bernouilli for a basis of an exact theory of the tides.

Thus far, we have regarded the tides only as if they were a fixed accumulation of waters under the proposed star. This is the mathematical basis of the whole question; but the most striking part has yet to be considered—the periodical rise and fall. It is the diurnal motion of our globe which causes this rise and fall, by carrying the waters successively into all the positions in which the other body can raise or depress them. Hence arise the four nearly equal periodical alternations, when the two greatest elevations take place during the two passages of the heavenly body over the meridian of the place, and the lower levels at its rising and setting; the total period being precisely fixed by combining the terrestrial rotation with the proper daily movement of the heavenly body. The last indispensable element of the question is the valuation of the powers of the different heavenly bodies. This calculation is easily made from the difference between the gravitation of the centre of our globe and that of the extreme points of its surface next the observed body. Guided by the law of gravitation, we can determine which, among all the bodies of our system, are those which can participate in the phenomenon, and what is the share taken by each. We thus find that the sun by its immense mass, and the moon by its proximity, are the only ones which produce any appreciable tides: that the action of the moon is from two and a half to three times more powerful than that of the sun; and that, consequently, when they act in opposite directions, that of the moon prevails; which explains the primary observation of Descartes about the coincidence of the tidal period with the lunar day.

Influence of the sun.

Of the moon.

Composite influence.

Thus far, we have considered only the effect of a single heavenly body upon the tides; that is, the case of a simple and abstract tide. The complication is very great, when the action of two such bodies has to be considered. But the resources of science are sufficient to meet this case—even deriving from it new means of estimating the mass of the sun and moon;—and also of calculating the modifications arising out of the various distances of the earth from either body; and again, of tracing the changes of direction caused by the diurnal movement of the proposed body—whether in accordance with the earth's axis of rotation, or parallel with the equator, which makes the difference between the tides of our equinoctial and solstitial lunar months. As for the difference of the phenomenon in various climates, the consideration of latitude is the only one which affords much result. At the poles, there can of course be no other tides than such as are caused by the flux and reflux of waters elsewhere, as the earth has no rotation there. The equator must exhibit the tides at their extremes, not only on account of the diminished gravitation there, but yet more on account of the more complete diversity of the successive positions occupied by the waters during the daily rotation. Elsewhere the greatness of the tide may vary in proportion to the force of the rotation.

Requisites for exactitude.

The mathematical theory of the tides accords with direct observation to a degree which is really wonderful, considering how many hypotheses geometers must have recourse to, to make the questions calculable at all, and how many inaccessible data would be required to make an estimate thoroughly logical. It would not even be enough to know the extent and form of the bed of the ocean. Something beyond that in difficulty is required—the true law of density, in the interior of the earth, as with regard to the figure of the planets. We ought to know, too, whether the interior strata are solid or fluid, in order to know whether they participate in tidal phenomena, and whether they therefore modify those at the surface or not. These considerations show the soundness of the advice given by one who was full of the true mathematical spirit, consisting above all in the relation of the concrete to the abstract, Daniel Bernouilli, who recommended geometers "not to urge too far the results of formulas, for fear of drawing conclusions contrary to truth."

The comparison between mathematical theory and direct observation has never been carried out to any advantage—all the measurements having been taken in the ports, or near the shore. The tides in such places are very indirect; and they can not properly represent the regular tides from which they issue, their force being chiefly determined by the form of the soil—at the bottom as well as on the surface—and even perhaps affected by its structure. These are incidents which can not enter into mathematical estimates; and to them we must doubtless refer the vast differences in the height of the tides at the same time, and in nearly the same place—as, for instance, the tides of Bristol and Liverpool, of Granville and Dieppe. The only way of making an effectual direct observation would be to note the phenomena of the tides in a very small island, at the equator, and thirty degrees at least from any continent, for such a course of years as would allow of repeated record of variations as repeatedly foreseen. In this way, and in no other, might the mathematical theory of the tides be verified and perfected.

Whatever may be the uncertainty with regard to some of the data of this great theory, it has that conclusive sanction,—the fulfilment of its previsions;—a fulfilment so exact as to guide our conduct; and this, as we know, is the true end of all science. The principal local circumstances, except the winds, being calculable, it has been found practicable to assign for each port the mean height of the tides and their times; and thus have mathematical determinations been proved to be sufficiently conformable to reality, and a class of phenomena which, a century ago, were regarded as inexplicable, have been referred to invariable laws, and shown to be as little arbitrary as anything else.

Such are the philosophical characteristics of the three great questions which compose the statical department of Celestial Mechanics. We must next look into the dynamical apartment, as represented by the phenomena of our system.

CHAPTER V.

CELESTIAL DYNAMICS.

Perturbations.

THE principal motion of the planets is, as we have seen, determined by the gravitation of each of them toward the focus of its orbit. The regularity of this movement must be impaired by the mutual gravitation of the bodies of the system. The most striking of those derangements were observed by the School of Alexandria, in the first days of Mathematical Astronomy; others have been observed, in proportion as our knowledge became more precise; and now, all are explained with such completeness by the theory of gravitation, that the smallest perturbations are known before they are observed. This is the last possible test and triumph of the Newtonian system.

Instantaneous.

There are, as Lagrange pointed out, two principal kinds of perturbations, which differ as much in their mathematical theory as in the circumstances which constitute them; instantaneous changes, from shocks or explosions, and gradual changes or perturbations, properly so called, caused by secondary gravitation, requiring time. The first kind may never have taken place in our system; but it is necessary to consider it, not only because it is of possible occurrence, but because it is a necessary preliminary to the study of the other kind,—the gradual perturbations being treated theoretically as a series of little shocks.

The first case is easy of treatment. No collision or explosion would affect Kepler's laws: and, if the form of the orbit was altered, the accelerating forces would remain the same; and thus, the new variation once understood, our calculations might proceed as before. Supposing a collision between two planets, or the breakage of one planet into several fragments by an internal explosion; there might be any variations whatever in the astronomical elements of their elliptical movement; but there are two relations which are absolutely unalterable, and which might, in my opinion, generally enable us to establish the reality of such an event at any period whatever: these are the essential properties of the continu ous motion of the centre of gravity, and the invariableness of the sum of the areas,—both resting on that great law of the quality of action and reaction to which all changes must conform. From these must result two important equations between the masses, the velocities, and the positions of the two bodies, or the two fragments of the same body, considered before and after the event. No indication at present leads us to suppose that the case of collision has ever occurred in our system; and it is evident that such an encounter, though not mathematically impossible, would be very difficult. But it is far otherwise with regard to explosions.

The little planets discovered between Mars and Jupiter have mean distances and periodic times so nearly identical, that Mr. Olbers has conjectured that they once formed a single planet, which had exploded into fragments. Lagrange added a supposition, from the irregularity of their form, that the event must have happened after the consolidation of the primitive planet. When their masses become known, I think this conjecture may be subjected to mathematical proof,—in this way. By calculating the positions and successive velocities of the centre of gravity of the system of these four planets, we might, if they had such an origin, retrace the principal motion of the primitive planet. If we should then find this centre of gravity describing an ellipse round the sun as a focus, and its vector radius tracing areas proportioned to the times, this event would be as completely established as any fact that we have not witnessed. We have not yet the materials for such a test; but it is interesting to see how celestial mechanics may establish, in a positive manner, events like these which appear to have left no evidence behind them. It is obvious that the instantaneous character of such a change must preclude our fixing any date for it, since the phenomena would be precisely the same, whether the explosion were recent or long ago. It is otherwise with regard to perturbations, properly so called.

Lagrange believed that these explosions had been frequent in our system, and that this was the true explanation of comets, judging from the greatness of their eccentricity and inclination, and the smallness of their masses. We have only to conceive that a planet may have burst into two very unequal fragments, the larger of which would proceed pretty nearly as before, while the smaller must describe a very long ellipse, much inclined to the ecliptic. Lagrange showed that the amount of impulsion necessary for this change is not great; and that it is less in proportion as the primitive planet is remote from the sun. This opinion is far from having been demonstrated; but it appears to me more satisfactory than any other that has been proposed on the subject of comets.

Gradual perturbations.

The important and difficult subject of perturbations is the principal object of celestial mechanics, for the perfecting of astronomical tables. They are of two classes; the one relating to motions of translation, the other of rotation. The latter are, as before, the most difficult: but the motions of rotation are less altered than the other class, within our own system; and they are less important to be known.

Perturbations of translation.

In the study of motions of translation, the planets must be treated as if they were condensed in their centres of gravity.

The direct method, the only rational one, of calculating the differential equations of the motion of any one planet, under the influences of all the rest, is impracticable, from the unmanageable complication of the problem. It would make an inextricable analytical enigma. Geometers have therefore been obliged to analyze directly the motion of each planet round that which is its focus, taking for modification only one at a time. This is what constitutes in general the celebrated problem of three bodies, though this denomination was at first employed only for the theory of the moon. It is easy to see what circumvolutions are involved in this method, since the modifying body, being in its turn modified by others, compels a return to the study of the primitive body, to understand its perturbations. The determination of the motions of the whole of our system must, by its very nature, be a single problem. It is the imperfection of our analysis which obliges us to divide it into detached problems, and to overload our formulas with multiplied modifications. The elementary problem of two bodies,—one of these even being regarded as fixed,—is the only one that we are capable of bringing to a solution; the problem of the elliptical motion, represented by Kepler's laws; and here the calculations are extremely laborious. It is to this type that geometers have to refer the motions of the planets, by extremely complicated approximations, accumulating the perturbations separately produced by every body that can be supposed to exert any influence; and these perturbations prescribe the series required for the integration of the equations belonging to the case of the three bodies.

Problem of three bodies.

Then follows the task of choosing the perturbations which have to enter into the estimate. The law of gravitation enables us to compare the secondary influences involved in each case,—the masses of all within our own system being supposed to be known. It is a favorable circumstance to mathematical research that our system is constituted of bodies of very small mass in comparison with the sun (making the perturbations extremely small); moreover, very few, very far from each other, and very unequal in mass; the result of all which is that, in almost every case, the principal motion is modified by only one body. If the contrary had been the case, the perturbations must have been very great, and extremely varied, since a great number of bodies must have powerfully acted in each disturbance. Celestial Mechanics must then, we should think, have presented an inextricable complication, being incapable of reduction to the problem of three bodies.

This study of modified motions divides itself into three parts, answering, as in a former case, to the planets, satellites, and comets. Rigorously speaking, we ought to make a fourth case of the sun, which can not here be regarded as motionless, because the planets react upon it. In fact, we can not allow ourselves to consider any point within the system as motionless, except the centre of gravity of the system itself, which is the true focus of planetary motion, and round which the sun itself must oscillate, in directions which vary according to the positions of the planets. This point is always between the centre and the surface of the sun. But we can not approach nearer to the fact than this: we shall probably never be able to indicate this centre precisely; and it is enough for practical purposes, and necessary to them, to consider the sun as fixed, except as to its rotary motion. The same conclusion must be come to with regard to the planets and their satellites,—even in the case of the earth and moon, where the variations of the primary body are greatest. The centre of gravity falling within the mass of the primary body, its variations from that centre may be neglected as having no appreciable influence on the motion of translation; and thus, celestial mechanics presents, in this branch, no other problems than those treated, under another point of view, by celestial geometry.

Centre of the Solar System.

Problem of the Planets.

The simplest problem is here, as before, that of the planets, and for the same reasons,—the smallness of their eccentricities, and of the inclinations of their orbits. There is also a considerable uniformity of perturbations, since each planet remaining in the same regions of the sky, continues in the same mechanical relations, though their intensity varies within certain limits. The least privileged of these bodies in these matters is unhappily our own planet, on account of the heavy satellite which escorts it so closely, and to which its chief perturbations are due; though this does not save it from being sensibly troubled by others, at the period of opposition, and especially by such a mass as that of Jupiter. No other planet with satellites, not even Jupiter, is in so unfavorable a case; for Jupiter's motion could not be very much deranged by the action of his satellites, however near in position, since the mass of the largest is less than a ten-thousandth part of his, while the mass of our moon is a sixty-eighth part of that of the earth. Jupiter's circulation is sensibly affected by Saturn alone. The simplest case of all seems to be that of Uranus, from its being the last planet, and very remote from the next; and its six satellites do not appear to trouble its motion.

Problem of the Satellites.

The problem of the satellites is necessarily more complicated than that of the planets, on account of the instability of the focus of the principal motion, as in celestial geometry. Besides their own perturbations, the satellites have reflected upon them all those to which their planet is liable. The founders of Celestial Mechanics were long perplexed, for instance, by the perpetual acceleration of the mean motion of the moon; it was considered inexplicable, till Laplace discovered its cause in the slight variation to which the eccentricity of the earth's orbit is subject

In regard to the direct perturbations of the satellites, there is an essential distinction between the case of one, and that of several satellites. In the first,—the single case of our moon,—the disturbing body is the sun, on account of its unequal action on the planets and its satellite. If the difficulties arising out of this position are greater than in the case of any other satellite, it is partly because the case more immediately concerns us, and because our opportunities of observation disclose more fully the imperfection of our means. For, in the mathematical point of view, there must be more complexity in the case of several satellites; all that is true in regard to one being true in regard to each one, with the addition of the mutual action of the members of the group. Their perturbations are reduced by the preponderating size of their planet; but, from there being so many of them, of such nearly equal sizes and direction, and all so close together, the difficulty of calculating their motions is so great that the only theory as yet established is that of the satellites of Jupiter. For the motions of three of them, Laplace found means completely to account. Those of Saturn and Uranus are known only geometrically, we having not even an approximate estimate of their masses. It is to be remembered, however, that we do not need so perfect a knowledge of them as of the moon; and that a much less exact theory will suffice for them than for the moon, whose slightest irregularity is very evident to us.

Problem of the Comets.

The comets intervene to increase our difficulties about the satellites. From the extreme prolongation of their orbits, and their inclination in all directions, comets are in a state of ever variable mechanical relations, from the number of bodies that they approach in their course; while the planets, and even the satellites, have always the same relations, the variation being only in the intensity. The perturbation which, in every other case, bears a very small proportion to the gravitation, may, in the case of comets, exceed it; so that it is conceivable that a comet might be diverted from its orbit, and become a satellite, when it passes near so considerable a body as Jupiter, Saturn, or even Uranus. Besides the eccentricities of comets, there are other circumstances, such as their small weight, and their possible loss of weight by parting with some of their atmosphere to the bodies they approach, which tend to perplex the study of their perturbations. These are the incidents which make it so difficult to foresee exactly the return of these little bodies. When we have studied them so long and so laboriously as to have, to the best of our belief, mastered their case, we find that their periods are entirely changed through one omitted circumstance. A memorable example of this was the comet of 1770, calculated by Lexell. This comet had then a revolution of less than six years: but it has never appeared since, having been entirely deranged by passing too near Jupiter. The imperfection of our knowledge about these small bodies is from the same cause that renders them of very little consequence to us. From their vast distances, their action upon any one body of the system is little more than momentary; and their lightness prevents even the satellites from being affected by their passage. The passage of the comet of 1770 among the satellites of Jupiter proved this, in a striking manner. Their tables, constructed beforehand, without any idea of such an incident, perfectly agreed with direct observations; a proof that the intrusion of the comet did not sensibly affect their motions. There is, therefore, no more occasion for the puerile fears of our day than for the religious terrors of former times, in regard to the passage of comets. Their collision with the earth is all but impossible; and they could not otherwise be felt at all. Their mere approach, however near, could have no other effect than to raise somewhat the corresponding tide. If a comet could pass two or three times nearer to us than the moon (which no known comet could do) its very small mass could produce no other effect than an imperceptible rise of the tides. We have, therefore, no immediate and practical reason to regret the imperfection of our cometary theories.

Perturbations of rotation.

Passing from the perturbations proper to motions of translation, we must notice those belonging to rotation. The ellipsoid bodies of our system must, whether they began or not, have ended, sooner or later, with turning round one of their axes,—and that one the most stable,—that of their smallest diameter: for, as we have seen, it is their rotation that has produced their deviation from a perfectly spherical form, and determined the direction favorable to stability. The regularity of this rotation is evidently so indispensable to the existence of living bodies on the surface of a planet, that we might, *a priori*, assert this stability wherever life is possible, from the time when it became possible. But, stable as each planet is in itself, its mutual gravitation with others must introduce certain secondary modifications, the bearing of which must be upon the direction of its axis in space. It is only with regard to the earth that these modifications concern us; for, however great they might be in any other body, they could in no way affect us.

The planets.

If the planets were perfect spheres, the total gravitation of their particles must pass through their centres of gravity; and thus, it is only through their slight failure in sphericity that they can act at all upon one another's rotation; that failure being caused by the rotation itself. We see here how the same necessity which secures the stability of the rotations, with regard to their duration and their poles, determines, from another point of view, the inevitable alteration of the parallelism of their axes.—In our own planet the precession of the equinoxes, modified by the nutation, results from the action of the other bodies of our system,—especially of the sun and moon,—upon our equatorial protuberance. The power of each body is, as in the case of the tides, in the direct ratio of its mass, and inversely to the cube of its distance; so that the sun and moon are the only bodies whose influence need be considered. Further, the extent of the deviation depends on the mass and magnitude of the earth, on the time of its rotation, on its degree of flattening, and on the obliquity of the ecliptic. The intensity of the influence must vary, as in the case of the tides, with the variable distance of the sun from the earth, and yet more of the moon; but the want of uniformity is too slight to be perceptible to direct observation.—These are the general causes which determine the small changes which the rotation of our globe undergoes, in regard to the direction of its axis in space.—The case of the other planets bears a general likeness to that of the earth, varied according to the different inclinations of their axes to their orbits, their position, their mass, their size, the duration of their rotation, and the degree of their flattening at the poles. On all these grounds, the perturbations of Mars are the most remarkable.

The satellites.

The rotation of the satellites presents one consideration of the highest interest,—that remarkable equality between the duration of this rotation and that of their circuit round their planet, by which they present always the same hemisphere, except from those very small oscillations called librations, whose law is well understood. The fact is absolutely certain only with regard to the moon; but our mechanical principles justify our erecting it into a general law of all the satellites. Lagrange has shown that it results from the preponderance that, by the action of the planet, the nearer hemisphere must acquire at the outset, whence arises a natural tendency in the satellite to return perpetually to the same position. If it is thus with the moon, there is every reason to suppose the same fact with regard to satellites belonging to heavier planets, to which they are proportionally nearer.

Device of an invariable plane.

Such are the various kinds of perturbations produced in the movements of the bodies of our system, by their mutual action. This study may be simplified and rendered much more exact, by the device of referring all these movements to a plane whose position must necessarily be independent of all their variations. Among several planes which have been proposed, differing in their degrees of variableness, M. Poinsot has discovered one which is the only truly invariable one, but which is extremely difficult to determine, since it requires not only an estimate of the planetary masses, but data dependent on the mathematical law of the interior density of the heavenly bodies,—a law which is still very hypothetical. The theory is complete; but its precise application is at present impossible. Whatever may be the practical difficulties, we can not but feel a deep interest in seeing how Celestial Mechanics has accomplished the fixing of an invariable plane in the midst of all the interior perturbations of our system, as Newton had first recognised an inalterable velocity,—that of the centre of general gravity. These are the only two elements in our system which are rigorously independent of all the events that can occur in its interior;—of even the vastest commotions that our imagination can suggest. Such variations as they can be conceived to have could relate only to the most general phenomena of the universe, produced by the mutual action of different suns, of which they would afford us the clearest manifestations, if such knowledge were within our reach.

Stability of our system.

We end this study of perturbations with a recognition of the stability of our own system, in regard to all its most important constituent bodies. Setting aside the comets, all the variations whatever of any perceptible value are periodical: and their period is usually very long, while their extent is very small; so that the whole of our planetary system can only oscillate with extreme slowness round a mean state, from which it deviates very little. Through all starry changes the translations of our planets present the almost rigorous invariableness of the great axes of their elliptical orbits, and of the duration of their sidereal revolutions: and their rotation shows a regularity even more perfect, in its duration, in its poles, and even, though in a somewhat smaller degree, in the inclination of its axis to the corresponding orbit. We know, for instance, that from the time of Hipparchus, the length of the day has not varied the hundredth part of a second. Amidst all this general regularity, we perceive a special and most marked stability with regard to the elements which are concerned in the continued existence of living beings.—Such are the sublime theorems of natural philosophy for which humanity is indebted to the sum of the great works executed in the last century by the successors of Newton.

The general cause of these important results lies in the small eccentricity of all the principal orbits, and the small divergence of their planes. If the planets had had cometary orbits and planes, there would have been no regularity—no periodicity,—and, we may add, no life upon their surface. No planets can be habitable but such as have their oscillations restricted within very narrow limits.

Resistance of a Medium.

The Mathematical theory of celestial mechanics has taken no notice, thus far, of the resistance of any general medium, in which these motions are proceeding. The conformity of our mathematical tables with observed facts shows that the resistance is imperceptible in degree; yet, as it is manifestly impossible that it should be null, the geometers have endeavored to prepare beforehand a general analysis of it. Considered apart from its intensity, this action is of a totally different nature from that of perturbations, though gradual like them: for it can not be periodical, and must always be exercised in the same direction, so as continually to diminish all velocities, and the more the greater they are. It can not alter the positions of the orbits, but can by possibility affect only their dimensions, and periodic times, and the duration of rotations: that is, it affects the elements which are spared by the perturbations. Thus, the rotations must become slower, the orbits must grow smaller and rounder, and their periodic times shorter; because, as velocity diminishes, the solar action must become more powerful, and these effects are not only continuous, but always increasing in rapidity. So, in a future too remote to be assigned, all the bodies of our system must be united to the solar mass, from which it is probable that they proceeded: and thus the stability of the system is simply in relation to the perturbations properly so called. These are among the incontestable indications of Celestial Mechanics.

As yet, we practically fail to recognise the effect of a resisting medium. We neither trace its operations, nor should know how to calculate it if we could trace it. Whenever we do, it will be by the study of comets; for their small mass, and the great surface which they present to the action of the medium when their atmospheres are widely diffused, must render its resistance much more appreciable than in the case of planets,—their velocity being besides naturally at its *maximum* at the moment of this expansion. Some contemporary astronomers believe that they have established the effect of this resistance in regard to one or two comets. Hitherto the study of these bodies seems to be only negatively useful, to prevent the return of the absurd terrors which they formerly occasioned. We now see that there is no body in our system, however insignificant, whose theory may not offer to us a direct and positive interest, since we may owe to comets the knowledge of one of the most important general laws of the system to which we belong, and that which, in a remote future, must chiefly rule its destinies.*

Independence of the solar system.

In our geometrical review we saw, by the agreement of astronomical tables with direct observation, that our system is independent of all that lies outside. This incontestable truth is confirmed by the mechanical view. If our system gravitated toward any of the suns outside, the action of other suns would nearly neutralize the tendency. Again, it would be only by an unequal action of those suns upon our planets that any change could be occasioned. Again, the vast distances would, according to our law of gravitation, make the action of remote suns imperceptible. The nearest body, if a million times heavier than our system, would produce an effect incalculably smaller than the action which occasions our tides. We may therefore pronounce the independence of our system to be perfectly certain. I notice this because we seem to find here the only exception to the great encyclopedical law which is the basis of this work,—that the most general phenomena rule the most particular, without being in any degree reciprocally influenced. Thus our astronomical phenomena regulate those of our own globe,—whether physical, chemical, physiological, or social. Yet here we find that the phenomena of the universe have no influence over those of the solar system. There is no difficulty about this to persons who, like myself, admit that our researches are limited by the boundaries of our own system, and that positive knowledge can not go beyond it. The study of the universe forms no part of natural philosophy; a truth which will become more apparent, and be seen to be more important the further our studies extend.

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* M. Comte estimates too lightly the indications of a medium given by Encke's comet.—J. P. N.

At the close of this brief review of celestial dynamics, we see that, great as are the achievements since Newton's time, we are reminded in many directions of the imperfection which results from the insufficiency of our mathematical analysis. In the execution of astronomical tables it has to borrow from celestial geometry other aid than the estimate of indispensable data, derived from direct observation; and this in regard not only to bodies whose mechanical theory is but just initiated, but with regard to some with which we are best acquainted.

Achievements of Celestial Dynamics.

We see, however, that, beside the sublime direct knowledge afforded to us, celestial dynamics has powerfully contributed to perfect the whole body of astronomical theories in regard to their definite aim—the exact prevision of the state of the heavens at any period whatever, past or future. Kepler's laws might suffice to determine the state of our system for a short time, proper data being chosen; but if we wish to extend the inquiry, back or forward, to any considerable period, we find the most perfect theory of perturbations absolutely necessary. It is to celestial dynamics that we owe our power of ranging up and down the centuries, to fix the precise moments of various celestial phenomena, such as eclipses, with certainty, and with a minuteness only inferior to that which is possible in the case of present events.

Though we have, according to my view, completed our consideration of astronomical science, it would be felt to be a great omission if we passed over altogether what is now called Sidereal Astronomy. We will therefore see how much there is that we can conceive to be positive in regard to cosmogony.

CHAPTER VI.

SIDEREAL ASTRONOMY AND COSMOGONY.

Multiple Stars.

The only branch of Sidereal Astronomy which appears to admit of exact study is that of the relative motions of the Multiple Stars, first discovered by Herschel. By multiple stars astronomers understand stars very near each other, whose angular distance never exceeds a half minute, and which, for this reason, appear to be one, not only to the naked eye, but to ordinary telescopes, only the most powerful lenses being able to separate them. The relative movements of these stars tend to deceive us as to their precise multiple character, as, for instance, by mutual occultations, which do not permit us to separate them.

Among some thousands of multiple stars registered in the catalogues, before the southern heavens had been really explored, almost all were only double, and we have found none which are more than triple—a circumstance which may be owing solely to the imperfection of our telescopes, as we knew of none but single stars before Herschel's time. However interesting the study of them is, they constitute only a particular case in the universe, as the intervals of the stars which compose them are probably much smaller than those which divide the suns of the universe, so that the study of their relative motions does not lead us up to any of the great general phenomena of the heavens, and the speciality would be more conspicuous if astronomers did what I think they ought—form their catalogues of those double stars only whose motions they have fully established. With regard to others, we can not be sure whether their duality is a real relation or an accident. Knowing nothing whatever of their interval, or of the distance of either of them from us, we can not be sure whether they form a system any more than any other two stars combined by chance in the heavens. Because a few incontestable examples are before us of a binary system, in which the smaller circulates round the larger, it is anything but philosophical to conclude the same to be the case with the whole multitude of double stars, some of which may appear so merely through an accident of position, apparent only to our own system. Analogy is not applicable here; as what looks like analogy is merely the imperfection of our investigations. No astronomer would venture to assert that if our telescopes were what they may one day become, we might not find between stars now apparently independent a multitude of clustered intermediate stars which should render the case of duality almost general. The apparent nearness would not then be a sufficient ground for presuming their mutual revolutions, because it is in virtue of their very small number that analogy now suggests that presumption. The only positive study in sidereal astronomy is that of the known relative motions of certain double stars, at present not more than seven or eight in number. We could never hope to assign with accuracy their orbits, or their periodic times, or any solid basis for dynamical conclusions.* The importance of such inquiries is much diminished by the consideration that our system, which, in such a case, means our sun, belongs to no groups of the kind—either investigated or merely pointed out. This circumstance seems to me not at all accidental; for, if our system made a part of a double star, which it is not difficult to imagine, it would probably be impossible for us ever to be aware of the other part of such a duality, because in the direction of the sun it would be so near that its light would be lost to us in that of our sun. Such a case might, however, have a scientific interest for us, not only as elucidating the displacements of our system, but as allowing such great precision as might arise from the position of the inquirer on one of the stars of the couple.

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* M. Comte quite underrates the importance of the phenomena of the multiple stars. The orbits of a very considerable number are now distinctly ascertained, and the laws of motion in their orbits. The existence of a motion of revolution is fixed, with regard to the far greater number.—J. P. N.

The first of the few orbits of double stars known to us was investigated by Savary. They all present a very considerable eccentricity, the smallest of which is double, and the greatest four times greater than that of the most eccentric in our system. Of their periodic times, the shortest slightly exceeds forty years, and the longest six hundred. We can not perceive that the eccentricity and the duration bear any fixed relation to each other, and neither seems to depend at all on the angular distance of the respective pairs of stars. This is the sum of what we know about the double stars; and unless we could learn something of their linear distance from our system and from each other, our conceptions can neither be accurate, nor of great importance. M. Savary has proposed a method, founded on the known velocity of light, by which these distances will, if ever, be estimated;* but the uncertainty of some of the elements which must enter into the question is so great that the most that can be hoped for is the fixing of certain limits within which the real distance may be supposed to lie; and this is all that M. Savary himself proposed. At present, we know only the nearer limit, beyond which, not only the double stars, but the whole starry host, are known to lie.

Our Cosmogony.

Proceeding now to ascertain what we may rationally conceive of our own cosmogony, I need hardly say that we must put aside altogether any notion of *creation*, as unintelligible—all that we are able to conceive of being successive *transformations* in the sky; and of these, only such as have produced its present state. Here, again, we find our own system to be the only subject of knowledge. We are in possession of some facts in regard to it which may bear testimony to its immediate origin; but we can form no reasonable conjectures about the formation of the suns themselves. The phenomena necessary for such a purpose are not only not explored, but not explorable. Whatever may be the interest of Herschel's curious observations on the progressive condensation of the nebulæ, they do not warrant his conclusion of their transformation into stars;† for from such a conclusion must flow consequences about form and motion which must be in harmony with established phenomena; and of these we have absolutely none.

Origin of Positive Cosmogony.

The beginning of positive cosmogony was when geometers, pursuing the mathematical theory of the figures of the planets, showed that they were originally in a state of fluidity. We can not go further back than this; and we must set out with an existing sun, turning on its axis with an indeterminate velocity, admitting, for the formation of the planetary system, no agencies which we do not now see at work, in the phenomena which we habitually witness, though they may have wrought formerly on a larger scale. These restrictions are indispensable to the scientific character of the inquiry; and, after all, our cosmogonic theories, however guarded, must remain essentially conjectural, if ever so plausible. No mathematical principles can enter here as into celestial mechanics, leading us up to a definite theory, and excluding every other. No abstract theory of formations is possible; and the utmost we can do is to collect such information as can be had, construct hypotheses from it, and compare them carefully and continuously with the whole of the phenomena that we explore. Such hypotheses, whatever degree of consistency they may attain, can never, like the law of gravitation, take rank among general facts: for we can never be sure that some other hypothesis may not turn up which would equally well answer the present purpose, and some others besides.

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* They are calculated; but by strictly geometrical methods.

† This portion of Herschel's speculation must be abandoned. What he fancied to be instances of nebulous matter turn out to be galaxies, or vast groups of stars.—J. P. N.

Cosmogony of Laplace.

The cosmogony of Laplace seems to me to present the most plausible theory of any yet proposed. It has the eminent merit of requiring, for the formation of our system, only the simple agents, weight and heat, which meet us everywhere, and which are the only two principles of action which are absolutely general. The point in which I differ from Laplace is with regard to comets, which he regards as strangers in our system; whereas Lagrange's view of them before cited, appears to be preferable, as being consistent with the independence of our solar group.

The hypothesis of Laplace tends to explain the general circumstances of our system, viz., the common direction of all the planets from west to east; that of their rotations; and that of all their satellites: also, the small eccentricity of all the orbits; and finally, the small inclination of their planes, especially in comparison with that of the solar equator.

It is supposed by this theory that the solar atmosphere was originally extended to the limits of our system, in virtue of its extreme heat; that it was successively contracted by cooling; and that the planets were formed by this condensation. The theory rests on two mathematical considerations. The first involves the necessary relation between the successive expansions or contractions of any body whatever and the duration of its rotation; by which the rotation should be quickened as the dimensions lessen and becomes slower as they increase, so that the angular and linear variations sustained by the sum of the areas become exactly compensated. The other consideration relates to the connection between the angular velocity of the sun's rotation and the possible extension of its atmosphere, the mathematical limit of which is at the distance at which the centrifugal force, due to this rotation, becomes equal to the corresponding gravity: so that if any portion of the atmosphere should be outside of this limit, it would cease to belong to the sun, though it must continue to revolve with the velocity it had at the moment of separation. From that moment, it ceases to be involved in any further consequences from the cooling of the solar atmosphere. It is evident, from this, how the solar atmosphere must have diminished, as to its mathematical limit, without intermission, in regard to the parts situated at the solar equator, as the cooling was for ever accelerating the rotation. Portions of the atmosphere, thus parted with, must form gaseous zones, situated just beyond the respective limits; and this constituted the first condition of our planets. By the same process the satellites were formed out of the atmospheres of their respective planets. Once detached from the sun, our planets must become first liquid and then solid, in the course of their own cooling, without being further affected by solar changes: but the irregularity of the cooling, and the unequal density of parts of the same body must change in almost every case, the primitive annular form, which remains in the rings of Saturn alone. .In most cases, the whole gaseous zone has gathered, in the way of absorption, round the preponderating portion of the zone as a nucleas: thence the body assumed its spheroidal form, with a revolving motion in the same direction as its movement of translation, on account of the excess of the velocity of the upper molecules in comparison with that of the lower.

This theory answers to all the appearances of our system, and explains the difficulty of the primitive impulsion of the planets. It shows, also, that the formation of the system has been successive, the remotest planets being the most ancient, and the satellites the most modern.*

If from points of view like these the stability of our system can scarcely be regarded as absolute, what it may lead us to suspect is that, by the continuous resistance of the general medium, our system must at length be reunited to the solar mass from which it came forth, till a new dilatation of this mass shall occur in the immensity of a future time, and organize in the same way a new system, to follow an analogous career. All these prodigious alternations of destruction and renewal must take place without affecting the most general phenomena, occasioned by the mutual action of the suns; so that these revolutions of our system, too vast to be more than barely conceived of by our minds, can be only secondary, even local events, in relation to really universal transformations. It is not less remarkable that the natural history of our system should be, in its turn, as certainly independent of the most prodigious changes that the rest of the universe can undergo: so that whole systems are, perhaps frequently, developed or condensed in other regions of space, without our attention being in any way drawn toward these immense events.

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* The author subjoins a proposed mathematical verification of Laplace's cosmogony, which is not given in the text, as it does not seem to rest on adequate foundations. If an arithmetical verification be ever obtained, it will probably be in connection with the periods of the *rotations* of the different planets;—periods already in so far connected with the nebular hypothesis by the investigations of an American inquirer—Mr. Kirkwood.—J. P. N.

Recapitulation.

The end I had in view in this exposition of astronomical philosophy will be attained if I have clearly exhibited, in regard both to method and to doctrine, the true general character of this admirable science, which is the immediate foundation of the whole Natural Philosophy. We have seen the human mind, by means of geometrical and mechanical researches, and with the help of constantly improving mathematical aids, attaining to a precision of logical excellence superior to any that other branches of knowledge admit of. We see the various phenomena of our system numerically estimated, as the different aspects of the same general fact, rigorously defined, and continually reproduced before our eyes in the commonest terrestrial phenomena; so that the great end of all our positive studies, the exact prevision of events, has been attained as completely as could be desired, in regard alike to the certainty and extent of the prevision. We have seen how this science must operate in liberating the human intellect for ever from all theological and metaphysical thraldom by showing that the most general phenomena are subjected to invariable relations, and that the order of the heavens is necessary and spontaneous. This last consideration belongs more particularly to a subsequent part of this work; but it has been our business to point out as we went along how the development of astronomical science has shown us that the universe is not destined for the passive satisfaction of Man; but that Man, superior in intelligence to whatever else he sees, can modify for his good, within certain determinate limits, the system of phenomena of which he forms a part —being enabled to do this by a wise exercise of his activity, disengaged from all oppressive terror, and directed by an accurate knowledge of natural laws. Lastly, we have seen that the field of positive philosophy lies wholly within the limits of our solar system, the study of the universe being inaccessible in any positive sense.*

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* As before remarked, M. Comte speaks much too absolutely here, in oversight of what modern astronomical researches have really accomplished.—J. P. N.

BOOK III.

PHYSICS.

CHAPTER I.

GENERAL VIEW.

Imperfect condition of the science.

ASTRONOMY was a positive science, in its geometrical aspect, from the earliest days of the School of Alexandria; but Physics, which we are now to consider, had no positive character at all till Galileo made his great discoveries on the fall of heavy bodies. We shall find the state of Physics far less satisfactory than that of Astronomy, not only on account of the greater complexity of its phenomena, but under its speculative aspect, from its theories being less pure and systematized, and, under its practical aspect, from its previsions being less extended and exact. The precepts of Bacon and the conceptions of Descartes have advanced it considerably in the last two centuries, in its character of a positive science; but the empire of the primitive metaphysical habits is not to be at once overthrown; and Physics could not be immediately imbued with the positive spirit, which Astronomy itself, our only completely positive science, did not assume in its mechanical aspect till the middle of that period. The further we go among the sciences, the more we shall find of the old unscientific spirit, and not only in their details, but impairing their fundamental conceptions. If we now compare the philosophy of Physics with the perfect model offered to us by astronomical philosophy, I hope we shall perceive the possibility of giving to it, and afterward to the other sciences in their turn, the same positivity as the first, though their phenomena are far from admitting of an equal perfection of simplicity and generality.

First, we must see what is the domain of Physics, properly so called.

Its domain.

Taken together with Chemistry (for the present), the object of the two is the knowledge of the general laws of the Inorganic world. This study has marked characters, to be analyzed hereafter, distinguishing it from the science of Life, which follows it in our encyclopedic scale, as well as from that of astronomy which precedes it. The distinction between Physics and Chemistry is much less easy to establish; and it is one more difficult to pronounce upon from day to day, as new discoveries bring to light closer relations between them. Though the division between these sciences is less obvious than between any other two in the scale, it is not the less real and indispensable, as we shall see by three considerations which, perhaps, might be insufficient apart, but which, when united, leave no uncertainty.

Compared with Chemistry.

First, the generality which characterizes physical researches contrasts with the specialty inherent in the chemical. Every physical consideration is applicable to all bodies whatever, while chemistry studies the action appropriate to a particular substance. If we look at their classes of phenomena, we find that gravity manifests itself in the same way in all bodies; and the same with phenomena of heat, of sound, of light, and even electrical effects. The difference is only in degree. But, in the compositions and decompositions of Chemistry, we have to deal with specific properties, which vary not in elementary substances, but in their most analogous combinations. The only exception which can be alleged, in the whole domain of Physics, is that of magnetic phenomena; but modern researches tend to prove that they are a mere modification of electrical phenomena, which are unquestionably general. The general properties of Physics were, in the metaphysical days of the science, regarded as consisting of two classes—those which were necessarily, and those which were contingently universal. But the false distinction arose from the notion of that age, that the business of science was to inquire into the nature of bodies,—the study of their properties being a mere secondary affair. Now that we know our business to be with the properties alone, we see the error, and need only ask whether we can conceive of any body absolutely devoid of weight, or of temperature.

Its generality.

In the second place, Physics relates to masses, and Chemistry to molecules; insomuch that chemistry was formerly called Molecular Physics. But, real as this distinction is, we must not carry it too far, but remember that purely physical action is often as molecular as chemical action; as in the case of gravity. Physical phenomena observed in masses are usually only the sensible results of those which are going on among their particles: and, at most, we can except from this only phenomena of sound, and perhaps of electricity. As for the necessity of a certain mass, to manifest physical action, that is equally indispensable in chemistry. The best way of expressing the general fact which lies at the bottom of this distinction is, perhaps, that in chemistry, one at least of the bodies concerned must be in a state of extreme division, while this is so far from being a

Dealing with masses or molecules.

necessary condition of physical action that it is rather an impediment to it. This is a proof of a real distinction between the two sciences, though it may not be a very marked one.

Changes of arrangement or composition of molecules.

In the third place, the constitution of bodies,—the arrangement of their molecules,—may be changed, in exhibiting physical phenomena; but the composition of their molecules remains unchangeable: whereas, in Chemistry, not only is there always a change of state in one of the bodies concerned, but the mutual action of the bodies alters their nature; and it is this alteration which constitutes the phenomenon. Many physical agents can, no doubt, work changes of composition and decomposition, if their operation be very energetic and prolonged; and it is this which forms such connection as there is between the two sciences: but, at that point of activity, physical agencies pass the boundary, and become chemical.

Positive philosophy requires that we should draw off altogether from the study of *agents*, to which it may be imagined that phenomena are to be referred. Any number of persons may discover a supposed agent; as, for instance, the universal ether of modern philosophers, by which a variety of phenomena may be supposed to be explained; and we may not be able to disprove such an agency. But we have no more to do with modes of operation than with the nature of the bodies acted upon. We are concerned with phenomena alone, and what we have to ascertain is their laws. In departing from this rule, we leave behind us all the certainty and consistency of real science.

Keeping within our true limits, then, we see that if chemical phenomena should be reduced by analysis into the form of purely physical actions,—an achievement very possible to the present generation of scientific men,—our fundamental distinction between the two sciences will not be shaken. It will still be true that in a chemical fact something more is involved than in a simply physical one: namely, the characteristic alteration undergone by the molecular composition of the bodies, and therefore by the whole of their properties. Such a distinction is secure amid any scientific revolution that can ever happen.

Description of Physics.

From these three considerations, taken together, we derive our description of Physics. This science consists in studying the laws which regulate the general properties of bodies, commonly regarded in the mass, and always placed in circumstances which admit of their molecules remaining unaltered, and generally in their state of aggregation. With a view to the great end of all science, we must add that the aim of physical theories is to foresee, as exactly as possible, all the phenomena that will be exhibited by a body placed in any set of given circumstances, excluding, of course, such as could alter its nature. This is not the less true because we can rarely attain the prescribed aim. The imperfection is in our knowledge alone. In estimating the true character of any science, the only way is, first, to suppose the science perfect, and then to study the fundamental difficulties presented by this ideal perfection.

Instruments.

Our description shows us how much more complexity we shall find in physical than in astronomical inquiries. In astronomy we study bodies, known to us only by sight, under two aspects only, their forms and motions. All considerations but these are excluded. But in Physics, on the contrary, the bodies we have to study are recognised by all our senses, and are regarded under an aggregate of general conditions, and therefore amid a complication of relations. It is clear, not only that this science is inferior to astronomy, but that it would be impracticable if the group of fundamental obstacles was not compensated for, up to a certain point, by the extension of our means of exploration. We meet here the law, before laid down, that in proportion as phenomena become complicated, they thereby become explorable under a proportionate variety of relations.

Methods of inquiry.

Observation.

Experiment.

Of the three procedures which constitute our art of observing, the last, Comparison, is scarcely more applicable here than with regard to astronomical phenomena. Its proper application is, in fact, to the phenomena of organized bodies, as we shall see hereafter. But the other two methods are entirely suitable to Physics. Observation was, in astronomy, restricted to the use of a single sense; but in Physics, all our senses find occupation. Yet would Observation effect little without the aid of Experiment, the regulated use of which is the great resource of physicists in all questions that involve any complexity. This procedure consists in observing beyond the range of natural circumstances;—in placing bodies in artificial conditions, expressly instituted to enable us to examine the action of the phenomena we wish to study under a particular point of view. We can see at once how eminently this art is adapted to physical researches; and how it must there find its triumphs: since there are hardly any bounds to our power of modifying bodies, for the purpose of studying their phenomena. In chemistry, experiment is commonly supposed to be more complete than in any other department: but I think it is of a higher order in physics, for the reason that in chemistry the circumstances are always artificially arranged, while in physics we have the choice of natural or artifical circumstances; and the philosophical character of experimentation consists in choosing the freest possible case that will show us what we want. We have a wider range, and a choice of simpler cases, in physics than in chemistry; and in physics, therefore, is experiment supreme.

Application of mathematical analysis.

The next great virtue of physics is its allowing the application of mathematical analysis, which enters into this science, and at present goes no further;—not yet, with real efficacy, into chemistry. It is less perfect in physics than in astronomy; but there is still enough of simplicity and fixedness in physical phenomena to allow of its extended use. Its employment may be direct or indirect:—direct when we can seize the fundamental numerical law of phenomena, so as to make it the basis of a series of analytical deductions; as when Fourier founded his theory of the distribution of heat on the principle of thermological action between two bodies being proportionate to the difference of their temperatures: and indirect, when the phenomena have been referred to some geometrical or mechanical laws; when, however, it is not properly to physics that the analysis is applied, but to geometry or mechanics. Such are the cases of reflection or refraction in the geometrical relation; and in the mechanical, the investigation of weight, or of a part of acoustics. In either case extreme care is requisite in the first application, and the further development should be vigilantly regulated by the spirit of physical research. The domain of physics is no proper field for mathematical pastimes. The best security would be in giving a geometrical training to physicists, who need not then have recourse to mathematicians, whose tendency it is to despise experimental science. By this method will that union between the abstract and the concrete be effected which will perfect the uses of mathematical, while extending the positive value of physical science. Meantime, the uses of analysis in physics are clear enough. Without it we should have no precision, and no co-ordination: and what account could we give of our study of heat, weight, light, etc.? We should have merely series of unconnected facts, in which we could foresee nothing but by constant recourse to experiment; whereas, they now have a character of rationality which fits them for purposes of prevision. From the complexity of physical phenomena, however, the difficulty of the mathematical application is great. In some, a part of the essential conditions of the problem must be thrown out, to admit of its transformation into a mathematical question; and hence the necessity for reserve in the employment of analysis. The art of combining analysis and experiment, without subordinating the one to the other, is still almost unknown. It constitutes the last advance of the true method of physical study; and it will be developed when physicists, and not geometers, conduct the analytical process, and not till then.

Encyclopedical Rank of Physics.

Having seen what is the object of Physics, and what the means of investigation, we have next to fix its position in the scientific hierarchy.

Relation to Astronomy.

The phenomena of Physics are more complicated than those of Astronomy; and Astronomy is the scientific basis and model of Physics, which can not be effectually studied otherwise than through the study of the more simple and general science. In this, we individually follow the course of our race. It was by Astronomy that the positive spirit was introduced into natural philosophy, after it had been sufficiently developed by purely mathematical investigations. Our individual education is in analogy with this: for we have learned from astronomy what is the real meaning of the *explanation* of a phenomenon, without any impracticable inquiry about its *cause*, first or final, or its mode of production. Physics should, more than the other natural sciences, follow closely upon astronomy, because, after astronomy, its phenomena are less complex than any.

Besides these reasons belonging to Method, there is the grand consideration that the theories of astronomy afford the only data for the study of terrestrial physics Our position in the solar system, and the motions, form, size, and equilibrium of the mass of our world among the other planets, must be known before we can understand the phenomena going on at its surface. What could we make of weight, for instance, or of the tides, without the data afforded by astronomical science? These phenomena indeed make the transition from astronomy to physics almost insensible. In this way Physics is indirectly connected with Mathematics. There is also a direct connection, as some physical phenomena have a geometrical and mechanical character,—as much as those of astronomy, though under a great complication of the circumstances. The abstract laws of space and motion must prevail as much in the one science as in the other. If the relation is thus unquestionable in the doctrine, it is not less so in the spirit and method which we must bring to the study of physics. It must be ever remembered that the true positive spirit first came forth from the pure sources of mathematical science; and it is only the mind that has imbibed it there, and which has been face to face with the lucid truths of geometry and mechanics, that can bring into full action its natural positivity, and apply it in bringing the most complex studies into the reality of demonstration. No other discipline can fitly prepare the intellectual organ. We might further say that, as geometrical ideas are more clear and fundamental than mechanical ideas, the former are more necessary, in an educational sense, to physicists than the latter, though the use of mechanical ideas is the more immediate and extended in physical science. Thus we see how we must conclude that the education of physicists must be more complicated than that of astronomers. Both have need of the same mathematical basis, and physicists must also have studied astronomy, at least in a general way. And this, again, assigns the position of their science.

Relation to Mathematics.

Its rank is equally clear, if we look in the opposite direction,—at the sciences which come after it.

It can hardly be by accident that, in all languages of thinking peoples, the word which originally indicated the study of the whole of nature should have become the name of the particular science we are now considering. Astronomy is, in fact, an emanation from mathematics. Every other natural science was once comprehended under the term Physics; and that to which it is now restricted must be supreme over the rest. Its relation to the rest is just this: that it investigates the general properties common to all bodies; that is, the fundamental constitution of matter; while the other sciences exhibit the modifications

Relation to the rest.

of those properties peculiar to each: and the study of those properties in the general must, of course, precede that of their particular cases. In regard to Physiology, for instance, it is clear that organized bodies are subject to the general laws of matter, those laws being modified in their manifestations by the characteristic circumstances of the state of Life. The same is the case with Chemistry. Without admitting the questionable hypothesis under which some eminent men of our time refer all chemical phenomena to purely physical action, it is yet evident that the concurrence of physical influences is indispensable to every chemical act. What could we make of any phenomenon of composition or decomposition, if we left out all data of weight, heat, electricity, etc.? And how could we estimate the chemical power of these various agents without first knowing the laws of the general influence proper to each? Chemistry is closely dependent on Physics; while Physics is wholly independent of Chemistry.

Relation to human progress. As for the direct operation of this science on the human intellect, it is less marked than that of the two natural sciences which occupy the extremities of the scale,—astronomy and physiology,—which immediately contemplate the two great objects of human interest,—the Universe and Man: but one striking fact with regard to physics is that it has been the great battle-ground between the old theological and metaphysical spirit and the positive philosophy. In Astronomy the positive philosophy took possession, and triumphed almost without opposition, except about the earth's motion; while in the domain of Physics the conflict has gone on for centuries; a circumstance attributable to the imperfection of physical, in comparison with astronomical science.

Human power of modifying phenomena. With this science begins the exhibition of human power in modifying phenomena. In Astronomy, human intervention was out of the question: in Physics it begins; and we shall see how it becomes more powerful as we descend the scale. This power counterbalances that of exact prevision which we have in astronomy, through its extreme simplicity. The one power or the other,—the power of foreseeing or of modifying,—is necessary to our outgrowth of theological philosophy. Our prevision disproves the notion that phenomena proceed from a supernatural will, which is the same thing as calling them variable: and our ability to modify them shows that the powers under which they proceed are subordinated to our own. The first is the higher order of proof; but both are complete in their way, and certain to command, sooner or later, universal assent. The proof which Franklin afforded of human control over the lightning destroyed the religious terror of thunder as effectually as the superstition about comets was destroyed by the prevision of their return; though the experiments by which Franklin established the identity of the lightning with the common electric discharge could be decisive only with physicists, while the generality of men could understand how the return of comets was foreseen. As the opposition between the theological and the positive philosophies becomes less simply evident, our power of intervention becomes more varied and extended; the amount of proof yielded in the two cases being equal in the eyes of men in general, though not strictly equivalent.

Prevision imperfect.

In regard to the speculative rank of Physics, it is clear that it does not admit of prevision to any extent at all comparable to that of astronomy, because it consists of numerous branches, scarcely at all connected with each other, and concurring only in a feeble and doubtful way in its chief phenomena. We can therefore see only a little way forward; often scarcely beyond the experiment in hand; but we shall see its speculative superiority to the sciences which come after it, when, in studying chemistry and physiology, we find another kind of incoherence existing among their phenomena, making prevision more imperfect still. The great distinction of Physics is that which has been referred to before,—that it instructs us in the art of Experiment. Philosophers must ascend to this source of experimentation, whatever their special objects may be, to learn what are the spirit and conditions of true experimentation,and what the necessary precautions.—Each of the sciences in the scale presents, besides the characters of the positive method which are common to them all, some indication appropriate to itself, which ought to be studied at its source, to be duly appreciated. Mathematical science exhibits the elementary conditions of positivity: astronomy determines the true study of Nature: physics teaches us the theory of experimentation: chemistry offers us the art of nomenclature: and physiology discloses the true theory of classification.

Characteristics of each science.

Philosophy of hypotheses.

I have deferred till now what I have to offer on the important subject of the rational construction and scientific use of *hypotheses*, regarded as a powerful and indispensable auxiliary to our study of nature. It is in the region of astronomy that I must take my stand in discussing this subject, though it was not necessary to advert to it while we were surveying that region. Hypothesis is abundantly employed in astronomy; but there it may be said to prescribe the conditions of its own use,—so simple are the phenomena in question there. Thence do I think it necessary to derive, therefore, our conceptions of the character and rules of this valuable resource, in order to its employment in the other departments of natural philosophy.

There are only two general methods by which we can get at the law of any phenomenon,—the immediate analysis of the course of the phenomenon, or its relation to some more extended law already established; in other words, by induction or deduction. Neither of these methods would help us, even in regard to the simplest phenomena, if we did not begin by anticipating the results, by making a provisional supposition, altogether conjectural in the first instance, with regard to some of the very notions which are the object of the inquiry. Hence the necessary introduction of hypotheses into natural philosophy. The method of approximation employed by geometers first suggested the idea; and without it all discovery of natural laws would be impossible in cases of any degree of complexity; and in all, very slow. But the employment of this instrument must always be subjected to one condition, the neglect of which would impede the development of real knowledge. This condition is to imagine such hypotheses only as admit, by their nature, of a positive and inevitable verification at some future time,—the precision of this verification being proportioned to what we can learn of the corresponding phenomena. In other words, philosophical hypotheses must always have the character of simple anticipations of what we might know at once, by experiment and reasoning, if the circumstances of the problem had been more favorable than they are. Provided this rule be scrupulously observed, hypotheses may evidently be employed without danger, as often as they are needed, or rationally desired. It is only substituting an indirect for a direct investigation, when the latter is impossible or too difficult. But if the two are not employed on the same general subject, and if we try to reach by hypothesis what is inaccessible to observation and reasoning, the fundamental condition is violated, and hypothesis, wandering out of the field of science, merely leads us astray. Our study of nature is restricted to the analysis of phenomena in order to discover their *laws*; that is, their constant relations of succession or similitude; and can have nothing to do with their *nature*, or their *cause*, first or final, or the mode of their production. Every hypothesis which strays beyond the domain of the positive can merely occasion interminable discussions, by pretending to pronounce on questions which our understandings are incompetent to decide.—Every man of science admits this rule, in its simple statement; but it cannot be practically understood,—so often as it is violated, and to such a degree as to alter the whole character of Physics. The use of conjecture is to fill up provisionally the intervals left here and there by reality; but practically we find the two materials entirely separated, and the real subordinated to the conjectural. It is necessary, therefore, to ascertain and explain the actual state of the question with regard to Physics.

Necessary condition.

Two classes of hypothesis.

The hypotheses employed by physical inquirers in our day are of two classes; the first, a very small class, relate simply to the laws of phenomena: the other, and larger class, aim at determining the general agents to which different kinds of natural effects may be referred. Now, according to the rule just laid down, the first kind alone are admissible; the second have an antiscientific character, are chimerical, and can do nothing but hinder the progress of science.

First class indispensable.

In Astronomy, the first class only is in use, because the science has a wholly positive character. A fact is obscure; or a law is unknown: we proceed to form an hypothesis, in agreement, as far as possible, with the whole of the data we are in possession of; and the science, thus left free to develop itself, always ends by disclosing new observable consequences, tending to confirm or invalidate, indisputably, the primitive supposition. We have before noticed frequent and happy examples of this method of discovering the primary truths of astronomy. But, since the establishment of the law of gravitation, geometers and astronomers have put away all their fancies of chimerial fluids causing planetary motions; or have, at least, indulged in them merely as a matter of personal taste, and not of scientific investigation. It would be well if, in a study so much more difficult as Physics, philosophers would imitate the astronomers. It would be well if they would confine their hypotheses to the yet unknown circumstances of phenomena, or their yet hidden laws, and would entirely let alone their mode of production, which is altogether beyond the limit of our faculties. What scientific use can there be in fantastic notions about fluids and imaginary ethers, which are to account for phenomena of heat, light, electricity, and magnetism? Such a mixture of facts and dreams can only vitiate the essential ideas of physics, cause endless controversy, and involve the science itself in the disgust which the wise must feel at such proceedings. These fluids are supposed to be invisible, intangible, even imponderable, and to be inseparable from the substances which they actuate. Their very definition shows them to have no place in real science; for the question of their existence is not a subject for judgment: it can no more be denied than affirmed: our reason has no grasp of them at all. Those who, in our day, believe in caloric, in a luminous ether, or electric fluids, have no right to despise the elementary spirits of Paracelsus, or to refuse to admit angels and genii. We find them spurning Lamarck's notion of a resonant fluid; but the misfortune of this hypothesis was that it came too late,—long after the establishment of acoustics. If it had been put forth as early in the days of science as the hypotheses about heat, light, and electricity, this resonant fluid would no doubt have prospered as well as the rest. Without going into the history of more of these baseless inquiries, it is enough to point out that they are irreconcilable with each other; and when superficial minds witness the ease with which they destroy each other, they naturally conclude the whole science to be arbitrary, consisting more in futile discussion than in anything else. Each sect or philosopher can show how untenable is the hypothesis of another, but cannot establish his own; and it would generally be easy to devise a third which might agree with both. It is true, physicists are now eager to declare that they do not attribute any intrinsic reality to these hypotheses; and that they countenance them merely as indispensable means for facilitating the conception and combination of phenomena. But we see here the working of an incomplete positivity, which feels the inanity of such systems, and yet dares not surrender them. But besides that it is scarcely possible to employ a fictitious instrument as a reality, without at times falling into the delusion of its reality, what rational ground is there for proceeding in such a way, when we have

Second class chimerical.

before us the procedure and achievements of astronomical science, for a pattern and a promise? These hypotheses *explain* nothing. For instance, the expansion of bodies by heat is not *explained*,—that is, cleared up,—by the notion of an imaginary fluid interposed between the molecules, which tends constantly to enlarge their intervals; for we still have to learn how this supposed fluid came by its spontaneous elasticity, which is, if anything, more unintelligible than the primitive fact. And so on, through the whole range. These hypotheses clear away no difficulties, but only make new ones, while they divert our attention from the true object of our inquiries. As for the plea that habit has so taken hold of the minds of inquirers, that they would be adrift if deprived of all their moorings at once, and that their language must be superseded by a wholly new one, I think this kind of difficulty is very much exaggerated. We have seen, within half a century, how often men have contrived to pass from some physical systems to their opposites without being much hindered by obstacles of language. There would be scarcely more difficulty in casting aside futile hypotheses; and we might, as we see by existing examples, gradually substitute the real and permanent meaning of scientific terms for the fanciful and variable interpretation.

History of the second class.

These fluids are nothing more than the odd entities materialized. Whichever way we look at it, what is heat apart from the warm body—light apart from the luminous body—electricity apart from the electric body? Are they not pure entities, like thought apart from the thinking body, and digestion apart from the digesting body? Here we have, instead of abstract beings, imaginary fluids deprived, by their very definition, of all material qualities, so that we can not even suppose in them the limit of the most rarefied gas. If the descent of these from the old entities be not recognised, what filiation of ideas can ever be admitted? The essential character of metaphysical conceptions is to attribute to properties an existence separate from the substance which manifests them. What does it matter whether we call these abstractions souls or fluids? The origin is always the same; and it is connected with that inquisition into the essence of things which always characterizes the infancy of the human mind, occasioning, first, the conception of gods, which grew into that of souls, which became in time imaginary fluids. In all positive science, our understandings, unable to pass abruptly from the metaphysical to the positive stage, have travelled through this transition state of development. Metaphysics itself is the transition stage from theology to positive science; but a secondary transition is also necessary, as we see by the fact; a transition from metaphysical to positive conceptions. The mathematicians and astronomers have attained the positive basis. The physicists, the chemists, the physiologists, and the social philosophers, are now in the last period of transition; the physical inquirers, ready to pass up to the level of the astronomers and geometers, and all the others held back for a while by the complexity of their respective subjects; as we shall see hereafter. This bastard positivism was the way out of the old metaphysical condition, in which men would, but for it, have been imprisoned to this day. Nascent science first humored the constitutional need, and then led us on by offering to our minds, in the place of the old scholastic entities, new entities, more tangible, which must by their nature introduce into our studies the contemplation of phenomena and their laws, restricting us to these more and more. This seems to have been the important temporary use of this system of hypotheses; to enable us to pass from the metaphysical to the positive stage.

In Astronomy.

Astronomy has not been exempted from this transition state, any more than the other sciences; but it was over so long ago that it is forgotten,—so few are those who are interested in the history of philosophy! If we look back to the action of the human mind in the seventeenth century, we shall see how geometers and astronomers were preoccupied with hypotheses of the kind we are considering. There is no better example of them than that famous conception, the Vortices of Descartes; for it presents clearly the three stages of existence common to them all; the creation of the hypothesis, its temporary use, and its rejection when its purpose is answered. These vortices, so ridiculed by men who believed in caloric, ether, and electric fluids, helped us to a sound philosophy by introducing the idea of mechanism, where even Kepler had imagined only the incomprehensible action of souls and genii. When the discussion had attained the firm ground of Celestial Mechanics, founded upon the Newtonian theory, the influence of the Cartesian hypothesis ceased to be progressive, and became retrograde. To the last, the Cartesian philosophers insisted, in arguments as plausible as those of our existing physicists, that it was impossible to philosophize without such a hypothesis. They were answered in the only effectual way, by philosophizing in another mode: and the vortices were heard of no more when geometers and astronomers apprehended the true object of scientific studies. The Cartesian hypothesis contributed to the education of the human mind by leading it to see that we have nothing to do with the primitive agents, or mode of production of phenomena, but only with their laws. If, in the other sciences, we have, as their professors assert, reached the stage of positivity, hypotheses like that of the vortices may be dismissed, as no longer needed to bring us out of the metaphysical state. As soon as they are needless, they become pernicious.

In Physics.

The transition has been obvious elsewhere than in astronomy. It has taken place in the most advanced departments of Physics; and especially with regard to Weight. There was scarcely a philosopher, even long after Galileo's time, who had not some system to offer about the causes of the fall of bodies. At that time, such hypotheses appeared the only method of studying weight; but who hears of them now? Acoustics was emancipated about the same time. The labors of Fourier will evidently release thermology; and then there will remain only the study of light and of electricity;* and no reason can be assigned for their exclusion from the general rule. The question will be regarded as settled henceforward by all who believe that the historical development of the human mind is subject to natural laws, determinate and uniform; and such will admit, as the principle of the true theory of hypotheses, that every scientific hypothesis, to be a matter of judgment, must relate exclusively to the laws of phenomena, and never to their mode of production.

Here we find, as in every analogous case of difficulty, the use of the comparative historical method which I have just employed. We shall enlarge on this hereafter: meantime, I must offer the observation that the philosophy of the sciences can not be properly studied apart from their history; and, conversely, that the history apart from the philosophy would be idle and unintelligible.

Rule of arrangement in Physics.

In reviewing the different departments of Physics, I shall follow the rule which determines the orders of the sciences themselves: that is, I shall take them in the order of the generality of their phenomena, their simplicity, the relative perfection of our knowledge of them, and their mutual dependence. Under this rule, we shall find that the departments that offer themselves first border upon Astronomy, and those that come last upon Chemistry.

First will come Weight, in solids and fluids, regarded statically and dynamically. About this assignment, there are no two opinions; weight being absolutely universal. Its phenomena are simple, independent of others, and so exactly understood that science is here almost as positive as in astronomy, to which it is very nearly allied. Electric phenomena being the most opposite of all to those of weight, in all these particulars, will come last; and they are closely allied to chemistry. Between them will come thermology, acoustics, and optics. Fourier put away, in his study of heat, all fantastic notions about imaginary fluids, and brought his subject up to such a point of positivity as to place it next to the study of gravity. Acoustics might, perhaps, contest its place with thermology, but for the generality of the phenomena of the latter. In regard to positivity, there is little to choose between them: but there are gaps in our knowledge of acoustics which also indicate the lower place for it. Our order then is,—Barology, or the science of weight: thermology, or the science of heat: acoustics, optics, and electricity. But we must beware of attaching too much importance to this arrangement, which is really little better than arbitrary, though as good as our present knowledge admits. We shall now proceed to a philosophical review of them, exempt from details; having, in this chapter, analyzed the proper object of Physics; the modes of investigation

Order.

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* In Electricity, the hypothesis of fluids is rapidly yielding before the rational idea of Polarity.—J. P. N.

appropriate to it; its position in regard to the other sciences; its influence upon the education of human reason; its degree of scientific perfection; its incomplete positivity at present; the means of remedying this by a sound institution of hypotheses; and finally the rational distribution of its different departments.

CHAPTER II.

BAROLOGY.

NOTWITHSTANDING the advanced state of our means for the study of Barology, we have no complete theory of weight, but only fragmentary portions of a theory, dispersed through treatises on rational mechanics or physics. It will be of great advantage to bring them together.

Divisions.

The division of the subject is into two principal sections, subdivided into three; the Statical and Dynamical consideration of weight, in its application to solids, liquids, and gases. Both philosophically and historically, this division is indicated.

SECTION I.

STATICS.

Statics of Gravity.

History.

TAKING the statics of gravity first, we must point out that we owe our elementary notions of positive barology to Archimedes. He first clearly established that the statical effort produced in a body by gravity—that is, *weight*—is entirely independent of the form of the surface, and depends only on the volume, as long as the nature and constitution of the body remain unchanged. This may appear to us very simple; but it is not the less the true germ of a leading proposition in natural philosophy, which was perfected only at the end of the last century; namely, that not only is the weight of a body independent of its form, and even of its dimensions, but of the mode of aggregation of its particles, and of all variations which can occur in their composition, even by the different vital operations; in a word, that this quality is absolutely unalterable, except by the circumstance of its distance from the centre of the earth Archimedes could take none but geometrical circumstances into the account; but, in this elementary relation, his work was complete. He not only discovered that, in homogeneous masses, the weight is always in proportion to the volume; but he disclosed the best means of measuring, in solid bodies, by his famous hydrostatic principle, the specific co-efficient which enables us to estimate, according to this law, the weight and volume of the body, by means of each other. We owe to him, too, the idea of the centre of gravity, together with the first development of the corresponding geometrical theory. Under this view, all problems respecting the equilibrium of solids are included in the domain of rational mechanics; so that, except the important relation of weight to masses, which could be fully known only to the moderns, Archimedes ought to be regarded as the true founder of statical barology, in relation to solids. There is, however, another leading idea which was not clear in the time of Archimedes, though it became so soon afterward: that of the law of the direction of gravity, which men spontaneously considered to be constant, and which the school of Alexandria ascertained to vary from place to place, always being perpendicular to the surface of the terrestrial globe; a discovery which is evidently due to astronomy, by which alone the means are offered of manifesting and measuring, by comparison, the divergence of verticals.

Cases of liquids.

The ancients had no accurate ideas about the equilibrium of liquids; for Archimedes contemplated only the equilibrium of solids sustained by liquids. His principle did not result, as with us, from an analysis of the pressure of the liquid against the vessel containing it, thus disclosing the total force exercised by the liquid in sustaining the weight. The theory of gravitating liquids is to be ascribed to the moderns.

The mathematical character of fluids is that their molecules are absolutely independent: and the geometrical character of liquids is that they are absolutely incompressible. Neither of these is strictly true. The mutual adherence of fluid molecules now forms an interesting section of physics; and, as for the compressibleness of liquids, it was indicated by several phenomena—especially the transmission of sound by water—and it is now proved by unquestionable experiments. The contraction, as yet producible, is very small; and we do not know what law the phenomenon follows, in its relation to variation of pressure. But this uncertainty does not affect the theory of the equilibrium of natural liquids, owing to the extreme smallness of the condensation. In the same way, imperfect fluidity is no hinderance, provided the mass has a certain extension. We may, therefore, put aside these exceptions, and proceed to consider the equilibrium of gravitating liquids, in the two cases in which they are studied: in a mass so limited that the verticals are parallel, which is the ordinary case; or in a great mass, as that of the sea, in which we have to allow for the variable direction of gravity.

First case.

In the first case, there is clearly no difficulty about the surface; and the whole question is of the pressure against the enclosing vessel. Stevinus, following the principle of Archimedes, showed that the pressure upon a horizontal boundary, or floor, is always equal to the weight of the liquid column of the same base which should issue at the surface of equilibrium; and he afterward resolved into this the case of an inclined boundary, by decomposing it into horizontal elements, as we now do. From this it appeared that the pressure is always equal to the weight of a vertical column which should have the proposed boundary for its base, and for its height that of the surface of equilibrium above the centre of gravity of this boundary. According to that, the infinitesimal analysis enables us easily to calculate the pressure against any definite portion of any curved surface. The most interesting physical result is the estimate of the total pressure supported by the whole of the vessel, which is necessarily equivalent to the weight of the liquid it contains. The equilibrium of floating bodies is only a simple application of this rule of measurement of pressure. The immersed part of the solid is a boundary; and it is clear that the pressure of the liquid to sustain the body is equivalent to a vertical force equal to the weight of the displaced fluid, and applied to the centre of gravity of the immersed portion. This rule is precisely the principle of Archimedes. The main problem was geometrically treated by him. The only really difficult research in this matter relates to the conditions of stability of this equilibirum, and the analysis of the oscillations of the body floating round its stable position; and this is one of the most complex applications of the dynamics of solids. If the question was of the vertical oscillations of the centre of gravity, the study would be easy, because we can estimate at once the way in which the pressure increases as the body is further immersed, and diminishes as it rises, tending always to a return to the primitive state. But it is otherwise with oscillations from rotation, whether of rolling or pitching, the theory of which is a matter of much interest in naval art. Here, the mathematical difficulties of the problem can be met only by abstracting the resistance and agitation of the liquid; and the labors of geometers become merely mathematical exercises, of no practical use.

Second case.

The question of the equilibrium of the vast liquid masses which compose the greater part of the earth's surface is clearly connected with the general theory of the form of the planets: but difficulties, unconnected with the figure of the planets, intervene, and can not be entirely surmounted. Rational hydrostatics shows us that equilibrium is possible when there is the same density at all points equally distant from the earth's centre; a condition which is impossible under our variety of temperatures in different positions. There is no rational result from any practicable study of currents, of varying temperatures, of the compressibleness of liquids, all of which, though following unknown laws, are necessary to the solution of the problem. We have no better resource, at present, than in empirical studies: and these, which belong more to the natural history of the globe than to physics, are very imperfect.

The theory of tides will hereafter, when sciences and their arrangements are more perfected, take its place in the department of barology. The periodical disturbances of the equilibrium of the ocean are a proper subject for study in connection with terrestrial gravity; and it can make no difference that the cause of those perturbations is found in the planetary system.

Case of gases.

In studying the third question of equilibrium, that of gases, we meet with a difficulty which does not pertain to that of solids and liquids;—we have to discover the gravity of the general medium in which we live. In the case of liquids, we have only to weigh an empty vessel, and then the same vessel filled; whereas, in the case of the atmosphere, a vacuum can not be created but by artificial means, which must themselves be founded on a knowledge of the weight of the medium to be weighed. The fact can be ascertained only by indirect means; and those are derived from the theories of pressure which we have been noticing. Stevinus was not thinking of the atmosphere in elaborating his theory; but, as it answered for heterogeneous liquids, it must answer for the atmosphere. From that date, the means for ascertaining the equilibrium of the atmosphere, in a positive manner, were provided. Galileo projected the work, in his last years; and it was well executed by his illustrious disciple, Torricelli. He proved the existence and measurement of atmospheric pressure by showing that this pressure sustained different liquids at heights inversely proportioned to their densities. Next, Pascal established the necessary diminution of this pressure at increasing heights in the atmosphere; and Guericke's invention of the air-pump, an inevitable result of Torricelli's discovery, gave us direct demonstration in the power of making a vacuum, and consequently of estimating the specific gravity of the air which surrounds us, which had hitherto been only vaguely computed. The creation and improvement of instruments of observation is an invariable consequence of scientific discovery; and in this case, the fruits are the barometer and the air-pump.

History.

One condition remained, before we could apply the laws of hydrostatics to atmospheric equilibrium. We had to learn the relation between the density of an elastic fluid and the pressure which it supports. In liquids (supposed incompressible) the two phenomena are mutually independent; whereas, in gases they are inevitably connected; and herein lies the essential difference between the mechanical theories of the two fluids. The discovery of this elementary relation was made about the same time by Mariotte in France and Boyle in England. These illustrious philosophers proved by their experiments that the different volumes successively occupied by the same gaseous masses are in an inverse ratio to the different pressures they receives. This law has since been verified by increasing the pressure to nearly that of thirty atmospheres; and it has been adopted as the basis of the whole Mechanics of gas and vapors. But we must beware of accepting it as the mathematical expression of the reality; for it is evidently the same thing as regarding elastic fluids as always equally compressible, however compressed they may already be; or, conversely, as always equally dilatable, however dilated they may already be:—suppositions which can not be indefinitely extended. But thus it is, more or less, with all the laws we have ascertained in our study of nature. They approximate, within narrow limits, we must suppose, to the mathematical reality: but they are not that reality itself, even in the grand instance of gravitation. These laws are sufficient for our use and guidance; and that is all the result that positive science pretends to.

Condition of the problem.

Under the law of Mariotte and Boyle, the theory of atmospheric equilibrium falls into the department of Rational Mechanics. We see at once that the air can no more be in a state of real equilibrium than the ocean; and so much the further from it as heat expands air more than water. Yet we must conceive of the partial equilibrium of a very narrow atmospheric column, to form a just general idea of the mode of diminution in regard to the density and pressure of the different strata. Putting aside considerations of heat, and the small effects of gravitation in such a case, we see that density and pressure must diminish in a geometrical progression for altitudes increasing in arithmetical progression: but this abstract variation is retarded by the diminishing heat of the loftier atmospheric strata, which makes each stratum more dense than it would be from its position. Here, therefore, we are stopped by the intervention of a new element which we do not understand,—the law of the vertical variation of atmospheric temperatures—our ignorance of which can be supplied only by inexact and uncertain expedients. Great caution is necessary in using Bouguer's method of measuring altitudes by the barometer; a method very ingenious, but depending on such complex and uncertain conditions, and requiring sometimes so much delay, that it is even preferable, when circumstances permit, to enter upon a geometrical measurement, which has so greatly the advantage in certainty. Yet, considered by itself, the method of measurement by the barometer is valuable for its contributions to our knowledge of the surface reliefs of our globe.

SECTION II.

DYNAMICS.

We have now to consider the laws of motion of gravitating bodies; and of Solids, in the first place.

The last elementary notion about gravity,—that of the necessary proportion between weight and mass,—which was still wanting to statical barology, was established by the admirable observation that all bodies in a vacuum fall through the same space in the same time. Proceeding from this, we must examine the discovery of the laws of motion produced by gravity. We shall find herein, not only the historical origin of physics, but the most perfect method of philosophizing of which the science admits. Aristotle observed the natural acceleration of bodies in their fall; but he could not discover the law of the case, for want

History.

of the elementary principles of rational dynamics. His hypothesis, that the velocity increases in proportion to the space traversed, was plausible, till Galileo found the true theory of varied motions. When Galileo had discovered the law that the velocity and the space traversed were necessarily proportioned, the one to the time, and the other to its square, he showed how it could be verified in two ways; by the immediate observation of the fall, or by retarding the descent at will by the aid of a sufficiently inclined plane,—allowance being made for the friction. An ingenious instrument, which affords a convenient verification, was afterward offered by Atwood: it retards the descent, while leaving it vertical, by compelling a small mass to move a very large one in that direction.

By this one law of Galileo, all the problems relating to the motions of falling bodies resolve themselves into questions of rational dynamics. They, indeed, compelled its formation, in the seventeenth century; as, in the eighteenth, questions of celestial mechanics thoroughly developed it. In all that relates to the motion of translation of a body in space, this study is due to Galileo, who established the theory of the curvilinear motion of projectiles—allowance being made for the resistance of the air. All attempts, however, to ascertain the effect of this resistance have hitherto been in vain; and therefore the study of the real motion of projectiles is still extremely imperfect.

As for the motions that gravity occasions in bodies that are not free in space,—the only important case is that of a body confined to a given curve. It constitutes the problem of the pendulum, which we have already considered, as the immortal achievement of Huyghens. Its practical interest, as the basis of the most perfect chronometry, presented itself first: but it has besides furnished two general consequences, very essential to the progress of barology. First, it enabled Newton to verify the proportion of weight to mass with much more exactness than would have been possible by the experiment of the fall of bodies in a vacuum; and, in the second place, the pendulum has enabled us, as we saw before, to observe the differences of the universal gravity at different distances from the earth's centre. It is by the use of this method that we are continually adding to our knowledge of the measure of gravity at various points on the globe, and, therefore, of the figure of the earth.

In these different sections of dynamical barology, solid bodies are regarded as points,—considerations of dimensions being discarded: but a new order of difficulties arises when we have to consider the particles of which the body is really formed. With regard to cases of restricted motion, as the pendulum, the thing to be done is to find out under what laws the different points of the body modify the unequal time of their respective oscillations, so that the whole may oscillate as one point, real or ideal. This law, discovered by Huyghens, and afterward obtained by James Bernouilli in a more scientific manner, easily transforms the compound into the simple pendulum, when the moment of inertia of the body is known. The study of pendulum is involved in all the questions of the dynamics of solids. To give it the last degree of precision, it is necessary to consider the resistance of the air, though that resistance is small in comparison with the case of projectiles. This is done, with ease and certainty, by comparing theoretical oscillations with real ones, exposed to the resistance of the air; when, of course, the difference between the two gives the amount of that resistance.

Fluids.

We have seen enough of the difficulties of hydrodynamics to understand that the part of dynamical barology which relates to fluids must still be very imperfect. In the cases of the gases, and especially of the atmosphere, next to nothing has been attempted, from the sense of the impracticable nature of the inquiry. The only analysis which has been proceeded with, in regard to liquids, is that of their flow by very small orifices in the bottom or sides of a vessel: that is, the purely linear motion, mathematically presented by Daniel Bernouilli, in his celebrated hypothesis of the parallelism of laminæ. Its principal result has been to demonstrate the rule, empirically proposed by Torricelli, as to the estimate of the velocity of the liquid at the orifice, as equal to that of a weight falling from the entire height of the liquid in the vessel. Now, this rule has been reconciled with observation, even on the supposition of an invariable level, only by an ingenious fiction, suggested by the singular phenomenon of the *contraction* of the liquid filament. The case of a variable level is scarcely entered upon yet; or any which involves the form and size of the orifice. As for more complex cases,—their theory is yet entirely in its infancy.*

Case of liquids.

Existing state of Barology.

From this cursory review of Barology we may carry away some idea of its spirit, and of the progress of which it admits. Imperfect as our survey has been, we may perceive that this first province of Physics is not only the purest, but the richest. We may observe in it a character of rationality, and a degree of co-ordination which we shall not meet with in other parts of the science. It is because we look for a consistency and precision almost like those that we find in astronomy that we consider barology so imperfect as we do. It has long attained its position of positivity: there is no one of its subdivisions which is not at least sketched out: all the general means of investigation, Observation, Experiment, and Comparison, have been successively applied to it; and thus its future progress depends only on a more complete harmony between these three methods, and on a more uniform and close combination between the mathematical spirit and the physical.

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* The subjects here spoken of by M. Comte have recently received remarkable elucidation through experiments entered upon chiefly by the instrumentality of the "British Association for the Advancement of Science." There can not be much hope, in the present state of our knowledge, of ascending otherwise than empirically toward any general law or rules which will either comprehend phenomena, or be of use in practice. —J. P. N.

CHAPTER III.

THERMOLOGY.

Its nature.

Next to the phenomena of gravity, those of heat are, unquestionably, the most universal in the province of Physics. Throughout the economy of terrestrial nature, dead or living, the function of heat is as important as that of gravity, of which it is the chief antagonist. The consideration of gravity presides over the geometrical and mechanical study of bodies: while that of heat prevails in its turn, when we investigate deeper modifications, relating to either the state of aggregation or the composition of molecules: and finally, vitality is subordinated to it. The intelligent application of heat constitutes the chief action of man upon nature. Thus, after barology, thermology is, of all the parts of physics, the one which most deserves our study.

Its history.

The earliest scientific observations in thermology are almost as old as the discoveries of Stevinus and Galileo on gravity, the invention of the thermometer having taken place at the beginning of the seventeenth century; but, owing to the complication of its phenomena, it has always been far distanced by barology. At the end of the seventeenth century, the indications of the thermometer could not be compared, for want of two fixed points, the necessity for which was, at that time, pointed out by Newton. The greatest difference between the two studies, however, was in their spirit. While philosophers were already inquiring, with regard to weight, what were its phenomena and their laws, those who were studying heat were looking for the nature of fire, and reducing the facts of the case to something merely episodical. It was only at the end of the last century that the great discovery of Black imparted anything of a scientific character to thermology, while barology was almost as much advanced as it is now. Our philosophers still entertain some of the old chimeras; but now very loosely, and, as they say, to facilitate the study of the phenomena. The labors of Fourier, however, must soon establish a thoroughly scientific method; and this result can not but be aided by the fact that the two great modern hypotheses about the nature of heat are in direct collision. It is certain that, of all the provinces of physics, thermology is the nearest to a complete emancipation from the anti-scientific spirit.

Relation to Mathematics.

Of all the branches of Physics which admit Mathematical Analysis, this is the one which exhibits the most special application of it. Barology enters into the province of rational mechanics; and so, in a less degree, does acoustics. The analytical theory of heat now offers a scientific character as satisfactory as that of gravity and sound; and it may be treated as a dependency of abstract Mechanics, without any resort to chimerical hypotheses. Our present business is, however, with the purely physical study of Heat.

SECTION I.

MUTUAL THERMOLOGICAL INFLUENCE.

Two parts.

PHYSICAL thermology consists of two parts, distinct, but nearly connected. The first relates to the mutual influence of two bodies in altering their respective temperatures. The second consists in the study of those alterations: that is, of the modifications or entire change which the physical constitution of bodies may undergo in consequence of their variations of temperature, stopping at the point at which chemistry intervenes,—that is, where the molecular composition becomes affected. The first of these consists in the theory of warming and cooling.

First: Mutual Influence.

No thermological effect is produced between bodies of precisely the same temperature. The action begins when the temperatures become unequal. The warmer body then raises the temperature of the cooler; and the cooler depresses that of the warmer, till, sooner or later, they reach a common temperature. Though the final state may usually be at an unequal distance from the two extremes, action is not, properly speaking, the less truly equivalent to reaction in a contrary direction. This case again divides itself into two. The bodies may act at a distance, greater or smaller; or they may be in contact The first case constitutes what is called the *radiation* of heat.

The direct communication of heat between two isolated bodies was long denied by philosophers, who regarded the air, or some other medium, as indispensable to the effect. But there is now no doubt about it; as thermological action takes place in a vacuum: and the small density and conducting power of the air could not account for the effects observed in the majority of ordinary cases. This action, like that of gravity, extends, no doubt, to all distances, in conformity to the fundamental approximation between these two great phenomena, pointed out by Fourier: for we can conceive of the planets of our system as exerting an appreciable mutual influence in this respect: and it seems as if the temperature of the whole solar system were attributable to the thermometrical equilibrium to which all the parts of the universe are for ever tending.

Radiation of Heat.

The first law relating to such an action consists in its rectilinear propagation. Though the term *radiation* has been connected with untenable hypotheses, we may retain it, provided we carefully restrict it to the meaning that it is in a right line that two points act thermologically on each other. It thus implies that in placing bodies to prevent this mutual action between two others, the absorbing body must be placed in a right line.—

This radiating heat can be reflected like light, and in conformity with the same rule: and it undergoes the same refractions as light, with some modifications.—Another question about this action relates to the influence of the direction of radiation considered in regard to the surface of either the warming or the warmed body. The experiments of Leslie, confirmed by the mathematical results of the case, have established that, in either case, the intensity of the action is greater as the rays approach the perpendicular, and that it varies in proportion to the sine of the angle that they form with each surface.—The last consideration, and the most important, is the difference of temperatures between the two bodies. When this difference is not very great, the intensity of the action is in precise proportion to it: but this relation appears to cease when the temperatures become very unequal.

When the radiation is not direct, but transmitted through an intermediate body, the conditions just noticed become complicated with new circumstances relating to the action of the interposed body. We owe to Saussure a fine series of experiments—hardly varied enough, however—upon the effect of a set of transparent coverings in changing remarkably the natural mode of accumulation or dispersion of heat, whether radiant or obscure. More recently, M. Melloni has pointed out an essential distinction between the transmission of heat and that of light, in proving that the most translucent bodies are not always those through which heat passes most easily, as was previously supposed.

Propagation by Contact.

It is well for physicists to separate the radiation of heat from its propagation by contact, for analytical purposes; but it is evident that the separation can not be found in nature. They are always found in connection, however unequally. Besides that the atmosphere can hardly be absent, and is always establishing an equilibrium of heat between bodies that are apart, it is clear that it is only the state of the surface that can be determined by radiation. The interior parts, which have as much to do with the final condition as the surface, can grow warmer or cooler only by contiguous and gradual propagation. Thus, no real case can be analyzed by the study of its radiation alone. And again, the action by contact of two bodies can take place only in those small portions which are in contact while the bodies are acting upon each other by the radiation of all the rest of their surfaces. Thus, though the two modes of action are really distinct, the analysis of either is rendered extremely difficult by their perpetual combination.

Of the three conditions noticed above, relating to the action exerted at a distance, the only one which applies equally to the propagation of heat by contact is the difference of temperatures. The temperature of the parts in question can have so little inequality, that the law which makes the action increase in proportion to the difference may be regarded almost as an exact expression of the fact. As for the law relating to direction, it probably subsists here too, though we can not be perfectly assured of it. But that law which relates to the distance must be totally changed; for, on the one hand, the action of the almost contiguous particles can not be nearly so great as the variations which we are able to estimate would lead us to suppose; and, on the other hand, when we compare the various small intervals between them, the diminution is certainly much more rapid than in the case of distant bodies.

Whatever may be the mode of the warming and cooling of respective bodies, the final state which is established under the laws just noticed is numerically determined by three essential coefficients, proper to every natural body, as its specific gravity is in barology.

Conductibility.

Under the old term *conductibility*, two properties were confounded, which Fourier separated, giving them the names of *penetrability* and *permeability;* the first signifying that by which heat is admitted at the surface, or dispersed from it, and the other that by which the changes at the surface are propagated through the interior.

Permeability.

Permeability depends altogether on the nature of the body and its state of aggregation. The differences of bodies in this respect have always been open to observation; for instance, the rapid propagation of heat in metallic bodies in comparison with coal, which may be burning at one point and scarcely warm a few inches off, while the heat rapidly pervades the whole body of metal. It varies with the physical constitution of bodies, so diminishing in fluids that even Rumford went so far as to deny permeability in them altogether, ascribing the propagation of heat in them to interior agitation. This was a mistake; but permeability is very weak in liquids, and weaker still in gases.

Penetrability.

As to penetrability, while partly depending on the state of aggregation of bodies, it depends much more on the state of their surfaces,—on color, polish, and the regularity in which radiation in various directions can take place, and divers other modifications: and it changes in the same surface as it is exposed to the action of different media.

Strictly speaking, the different degrees of these two kinds of conductibility can not affect the final thermological state of the two bodies, but only the time at which it is reached. Yet, as real questions often become mere questions of time, it is clear that if the inequalities are very marked, they must affect the intensity of the phenomena under study; for instance, where the permeability is so feeble that the requisite interior heat can not be obtained in time, but by applying such heat to the surface as will break or burn it; in which case, the phenomenon can not take place; or, not within any practicable time. In general, the more perfect both kinds of conductibility, the better the bodies will obey the laws of thermological action, at a distance or in contact. It would therefore be very important to measure the value of these two coefficients for all bodies under study: but unhappily such estimates are at present extremely imperfect. The business was vague enough, of course, when the two kinds of conductibility were confounded; but Fourier has taught us how to estimate permeability directly, and of course, penetrability indirectly, by subtracting the permeability from the total of conductibility. But the application of his methods is as yet hardly initiated.

Specific heat. One consideration, that of *specific heat*, remains to be noticed, as concurring to regulate the results of thermological action. Whether under conditions of equal weight, or of equal volume, the different substances consume distinct quantities of heat to raise their temperature equally. This property, of which little was known till the latter half of the last century, depends, like permeability, only in a less degree, on the physical constitution of bodies, while it is independent of the state of their surfaces. It must considerably affect the equalized temperature common to two bodies, which can not be equally different from the primitive temperature of each, if they differ from each other in the point of their specific heat. Physicists have achieved a good deal in the estimate of specific heat. The best method is that of experiment with the calorimeter, invented by Lavoisier and Laplace, for its measurement. The quantity of heat consumed by any body at a determinate elevation of temperature, is estimated by the quantity of ice melted by the heat it gives out in its passage from the highest to the lowest temperature. The apparatus is so contrived as to isolate the experiment from all thermological action of the vessel and of the medium; and thus the results obtained are as precise as can be desired.

There are the three coefficients which serve to fix the final temperatures which result from the thermological equilibrium of bodies. Till we know more of the laws of their variations, it is natural to suppose them essentially uniform and constant: but it would not be rational to conceive of conductibility as identical in all directions, in all bodies, however their structure may vary in different directions; and specific heat probably undergoes changes at extreme temperatures, and especially in the neighborhood of those which determine a new state of aggregation, as some experiments already seem to indicate. However, these modifications are still so uncertain and obscure, that physicists can not be blamed for not keeping them, at this day, perpetually in view.

SECTION II.

CONSTITUENT CHANGES BY HEAT.

Second part. Constituent changes by heat. THE second part of thermology is that which relates to the alterations caused by heat in the physical constitution of bodies. These alterations are of two kinds; changes of volume, and the production of a new state of aggregation; and this is the part of thermology of which we are least ignorant.

These phenomena are independent of those of warming and cooling, though they are found together. When we heat any substance, the elevation of temperature is determined solely by the portion of heat consumed, the rest of which (often the greater part), insensible to the thermometer, is absorbed to modify the physical constitution. This is what we mean when we say that a portion of heat has become latent; a term which we may retain, though it was originally used in connection with a theory about the nature of heat. This is the fundamental law discovered by Black, by observation of the indisputable cases in which a physical modification takes place without any change of temperature in the modified body. When the two effects co-exist, it is much more difficult to analyse and apportion them.

Latent heat.

Change of volume.

Considering first the laws of change of volume, it is a general truth that every homogeneous body dilates with heat and contracts with cold; and the fact holds good with heterogeneous bodies, such as organized tissues especially, in regard to their constituent parts. There are very few exceptions to this rule, and those few extend over a very small portion of the thermometrical scale. The principal anomaly however being the case of water, it has great importance in natural history, though not much in abstract physics, except from the use that philosophers have made of it to procure an invariable unity of density, always at command. These anomalies, too rare and restricted to invalidate any general law, are sufficient to discredit all *à-priori* explanations of expansions and contractions, according to which every increase of temperature should cause an expansion, and every diminution a contraction, contrary to the facts.

Solids dilate less than liquids, under the same elevation of temperature, and liquids than gases; and not only when the same substance passes through the three states, but also when different substances are employed. The expansion of solids proceeds, as far as we know, with perfect uniformity. We know more of the case of liquids, which is rendered extremely important from its connection with the true theory of the thermometer, without which all thermological inquiries would be left in a very dubious state. Experiments, devised by Dulong and Petit, have shown that for above three hundred centigrade degrees the expansion of the mercury follows an exactly uniform course,—equal increase of volume being produced by heat able to melt equal weights of ice at zero. This is the only case fully established; but we have reason to believe that the rule extends to that of all liquids. The most marked case of such regularity is that of gases. Not only does the expansion take place by equal gradations, as usually in liquids and solids, but it affects all gases alike. Gases differ from each other, like liquids and solids, in their density, their specific heat, and their permeability; yet they all dilate uniformly and equally, their volume increasing three eights, from the temperature of melting ice to that of boiling water. Vapors are like gases in this particular, as in so many others. These are the simple general laws of the expansion of elastic fluids, discovered at once by Gay-Lussac at Paris, and Dalton at Manchester.

Change in state of aggregation.

Next, we have to notice the changes produced by heat in the state of aggregation of bodies.

Solidity and fluidity used to be regarded as absolute qualities of bodies; whereas, we now know them to be relative, and are even certain that all solid bodies might be rendered fluid if we could apply heat enough, avoiding chemical alteration. In the converse way, we used to suppose that gases must preserve their elasticity, through all degrees of cooling and of compression; whereas Bussy and Faraday have shown us that most of them easily become liquid, when they are seized in their nascent state; and there is every reason to believe that by a due combination of cold and pressure, they may be always liquefied, even in their developed state. Under this view, therefore, different substances are distinguished only by the different parts of the indefinite thermometrical scale to which their successive states, solid, liquid, and gaseous, correspond. But this simple inequality is an all-important characteristic, which is not yet thoroughly connected with any other fundamental quality of each substance. Density is the relation which is the least obscure and variable—gases being in general less dense than liquids, and liquids than solids. But there are striking exceptions in the second case, and might be in the first if we know more of gases in regard to compression, and in varied circumstances of other kinds. As for the three states of the same substance, there is always, except in some cases of scarce anomaly, rarefaction in the fusion of solids and in the evaporation of liquids. All these changes have been brought by the illustrious Black under one fundamental law, which is, both from its importance and its universality, one of the finest discoveries in natural philosophy. It is this: that in the passage from the solid to the liquid state, and from that to the gaseous, every substance always absorbs a more or less distinguishable quantity of heat, without raising its temperature; while the inverse process occasions a disengagement of heat, precisely correspondent to the absorption. These disengagements and absorptions of heat are evidently, after chemical phenomena, the principal sources of heat and cold. In an experiment of Leslie's, an evaporation, rendered extremely rapid by artificial means, has produced the lowest temperatures known. Eminent natural philosophers have even believed that the heat which is so abundantly disengaged in most great chemical combinations could proceed only from the different changes of state which commonly result from them. But this opinion, though true in regard to a great number of cases, has too many exceptions to deal with to become a general principle.

Law of engagement and disengagement of heat.

Vapors.

We have now done with physical thermology. But the laws of the formation and tension of vapors now form an appendix to it; and also of course hygrometry. The theory is, in fact, the necessary complement of the doctrine of changes of state; and this is its proper place.

Before Saussure's time, evaporation was regarded as a chemical fact occasioned by the dissolving action of air upon liquids. He showed that the action of the air was adverse to evaporation, except in the case of the renovation of the atmosphere. The test was found in the formation of vapor in a restricted space. Saussure found that, in such a case, with a given time, temperature, and space, the quantity and elasticity of the vapor were always the same, whether the space was a vacuum or filled with gas. The mass and tension of the vapor increased steadily with the temperature; whereas it appears that no degree of cold suffices to stop the process entirely, since ice itself produces a vapor appreciable by very delicate means of observation. We do not know by what law the increase of temperature accelerates the evaporation, at least while the liquid remains below boiling point; but the variations in elasticity of the vapor produced have been successfully studied.

Temperatures of ebullition.

One term common to all liquids is the boiling point. At that point, the rising tension of the vapor formed has become equal to the atmospheric pressure; a fact which can be ascertained by direct experiment. Proceeding from this point, Dr. Dalton discovered the important law that the vapors of different liquids have tensions always equal between themselves to temperatures equi-distant from the corresponding boiling points, whatever may be otherwise the direction of the difference. Thus, the boiling of water taking place at one hundred degrees, and that of alcohol at eighty degrees, the two vapors, having at that point the same tension, equal to the atmospheric pressure, will then have equal elasticities, superior or inferior to the preceding, when their two temperatures are made to vary in the same number of degrees. The many new liquids discovered by chemists since this law was found have all tended to confirm it. It is very desirable that some harmony should be discovered between the boiling temperatures of different liquids and their other properties; but this remains to be done, and these temperatures appear to us entirely incoherent, though there is every reason to believe that they are not so.

It is evident that this law of Dalton's simplifies prodigiously the inquiry into the variation of the tension of vapors, according to their temperatures; since the analysis of these variations in one instance will serve for all the rest. The experiments undertaken for this purpose by Dr. Dalton and his successors have not fully established the rule of proportion between the tension and the temperature: but an empirical law proposed by Dulong has thus far answered to the observed phenomena. All *à-priori* determinations of the law have utterly failed.

Hygrometical equilibrium.

The study of hygrometrical equilibrium between moist bodies seems a natural adjunct to the theory of evaporation. Saussure and Deluc have given us a valuable instrument for this inquiry; but we know scarcely anything of the laws which regulate the equilibrium of moisture. Prevision, which is the exact measure of science of every kind, is almost non-existent in the case of hygrometry. The small part that it plays in the inorganic departments of nature is, no doubt, the reason of the little attention that physicists have devoted to it; but we shall hereafter find how important is its share in vital phenomena. According to M. de Blainville, hygrometrical action constitutes the first degree and elementary mode of the nutrition of living bodies, as capillarity is the germ of the most simple organic motions. In this view, the neglect is much to be regretted. It is one instance among a multitude of the mischiefs arising from the restricted training of natural philosophers. In this case, two important studies, which can be accomplished only by physical inquirers, are neglected, merely because their chief destination concerns another department of science.

After this survey, we can form some idea of the characteristics of this fine section of Physics. We see the rational connection of the different questions comprised in it; the degree of perfection which each of them has attained; and the gaps which remain to be filled up. A vast advance was made when, by the genius of Fourier, the most simple and fundamental phenomena of heat were attached to an admirable mathematical theory.

SECTION III.

CONNECTION WITH ANALYSIS.

Thermology connected with Analysis.

This theory relates to the first class of cases—those in which an equalization of heat takes place between bodies at a distance or in contact; and not at all to those in which the physical constitution is altered by heat. It is only by an indirect investigation that we can learn how heat, once introduced into a body from the surface, extends through its mass, assigning to each point, at any fixed moment, a determinate temperature; or the converse—how this interior heat is dissipated, by a gradual dispersion through the surface. As direct observation could not help us here, we must remain in ignorance, if Fourier had not brought mathematical analysis to the aid of observation, so as to discover the laws by which these processes take place. The perfection with which this has been done opens so wide a field of exploration and application, unites so strictly the abstract and the concrete, and is so pure an example of the positive aim and method, that future generations will probably assign to this achievement of Fourier's the next place, as a mathematical creation, to the theory of gravitation. Many contemporaries have hastened into the new field thus opened; but most of them have used it only for analytical exercises which add nothing to our permanent knowledge; and perhaps the labors of M. Duhamel are hitherto the only ones which afford really any extension of Fourier's theory, by perfecting the analytical representation of thermological phenomena.

According to the plan of this work, we ought not to quit the limits of natural philosophy to notice any concrete considerations of natural history—the secondary sciences being only derivatives from the primary. It is departing from our rule, therefore, to bring forward the important theory of terrestrial temperatures; yet this most important and difficult application of mathematical thermology forms so interesting a part of Fourier's doctrine, that I can not refrain from offering some notice of it.

SECTION IV.

TERRESTRIAL TEMPERATURES.

Terrestrial temperatures.

The temperature of each point of our globe is owing (putting aside local or accidental influences) to the action of three general and permanent causes variously combined: first the solar heat, affecting different parts unequally, and subjected to periodical variations; next, the interior heat proper to the earth since its formation as a planet; and thirdly the general thermometrical state of the space occupied by the solar system. The second is the only one of the three which acts upon all the points of the globe. The influence of the two others is confined to the surface. The order in which they have become known to us is that in which I have placed them. Before Fourier's time the whole subject had been so vaguely and carelessly regarded, that all the phenomena were ascribed to solar heat alone. It is true, the notion of a central heat was very ancient; but this hypothesis, believed in and rejected without sufficient reason, had no scientific consistency—the question having never been raised of the effect of this original heat on the thermological variations at the surface. The theory of Fourier afforded him mathematical evidence that at the surface the temperatures would be widely different from what they are, both in degree and mutual proportion, if the globe were not pervaded by a heat of its own, independent of the action of the sun; a heat which tends to dispersion from the surface, by radiation toward the planets, though the atmosphere must considerably retard this dispersion. This original heat contributes very little, in a direct way, to the temperatures at the surface; but without it, the solar influence would be almost wholly lost, in the total mass of the globe; and it therefore prevents the periodical variations of temperature from following other laws than those which result from the solar influence. Immediately below the surface, the central heat becomes preponderant, and soonest in the parts nearest the equator; and it becomes the sole regulator of temperatures, and in a rigorously uniform manner, in proportion to the depth. As to the third cause, Fourier was the first to conceive of it. He was wont to give, in a simple and striking form, the results of his inquiries in the saying that if the earth left a thermometer behind it in any part of its orbit, the instrument (supposing it protected from solar influence) could not fall indefinitely: the column would stop at some point or other, which would indicate the temperature of the space in which we revolve. This is one way of saying that

Interior heat.

Temperature of the planetary intervals.

the state of the temperatures on the surface of the globe would be inexplicable, even considering the interior heat, if the surrounding space had not a determinate temperature differing but little from that which we should find at the poles, if we could precisely estimate it. It is remarkable that, of the two new thermological causes discovered by Fourier, one may be directly observed at the equator, and the other at the poles; while, for all the intermediate points, our observation must be guided and interpreted by mathematical analysis.

New as this difficult inquiry is, our progress in it depends only on the perfecting of the observations which Fourier's theory has marked out for us. When the data of the problem thus become better known, this theory will enable us to lay hold of some certain evidences of the ancient thermological state of our globe, as well as of its future modifications. We have already learned one fact of high importance; that the periodical state of the earth's surface has become essentially fixed, and can not undergo any but imperceptible changes by the continuous cooling of the interior mass through future ages. This rapid sketch will suffice to show what a sudden scientific consistency has been given, by the labors of one man of genius, to this fundamental portion of natural history, which, before Fourier's time, was made up of vague and arbitrary opinions, mingled with incomplete and incoherent observations, out of which no exact general view could possibly arise.

CHAPTER IV.

ACOUSTICS.

Its nature.

THIS science had to pass, like all the rest, through the theological and metaphysical stages; but it assumed its positive character about the same time with Barology, and as completely, though our knowledge of it is, as yet, very scanty, in comparison with what we have learned of gravity. The exact information which was obtained in the middle of the seventeenth century about the elementary mechanical properties of the atmosphere, opened up a clear conception of the production and transmission of sonorous vibrations. The analysis of the phenomena of sound shows us that the doctrine of vibrations offers the exact expression of an incontestable reality. Besides its philosophical interest, and the direct importance of the phenomena of Acoustics, this department of Physics appeals to special attention in two principal relations, arising from its use in perfecting our fundamental ideas regarding inorganic bodies, and Man himself.

Relation to the study of inorganic bodies.

By studying sonorous vibrations, we obtain some insight into the interior mechanical constitution of natural bodies, manifested by the modifications undergone by the vibratory motions of their molecules. Acoustics affords the best, if not the only means for this inquiry; and the small present amount of our acquisitions seems to me no reason why we should not obtain abundant results when the study of acoustics is more advanced. It has already revealed to us some delicate properties of natural bodies which could not have been perceived in any other way. For instance, the capacity to contract *habits*—a faculty which seemed to belong exclusively to living beings (I mean the power of contracting fixed dispositions, according to a prolonged series of uniform impressions)—is clearly shown to exist, in a greater or smaller degree, in inorganic apparatus. By vibratory motions, also, two mechanical structures, placed apart, act remarkably upon each other, as in the case of two clocks placed upon the same pedestal.

Relation to Physiology.

On the other hand, acoustics forms a basis to physiology for the analysis of the two elementary functions which are most important to the establishment of social relations—hearing and the utterance of sound. Putting aside, in this place, all the nervous phenomena of the case, it is clear that the inquiry rests on a knowledge of the general laws of acoustics, which regulate the mode of vibration of all auditory apparatus. It is remarkably so with regard to the production of the voice,—a phenomenon of the same character with that of the action of any other sonorous instrument, except for its extreme complication, through the organic variations which affect the vocal system. Yet, it is not to physicists that the study of these two great phenomena belongs. The anatomists and physiologists ought not to surrender it to them, but to derive from physics all the ideas necessary for conducting the research themselves: for physicists are not prepared with the anatomical data of the problem, nor yet to supply a sound physiological interpretation of the results obtained. Science has indeed suffered from the prejudices which have grown out of the introduction into physics of superficial theories of hearing and phonation, from physical inquirers having intruded upon the province of the physiologists.

Relation to Mathematics.

After Barology, there is no science which admits of the application of mathematical doctrines and methods so well as Acoustics. In the most general view, the phenomena of sound evidently belong to the theory of very minute oscillations of any system of molecules round a situation of stable equilibrium; for, in order to the sound being produced, there must be an abrupt perturbation in the molecular equilibrium; and this transient derangement must be followed by a quick return to the primitive state. Once produced, in the body directly shaken, the vibrations may be transmitted at considerable intervals by means of an elastic medium, by exciting a gradual succession of expansions and contractions which are in evident analogy with the waves formed on the surface of a liquid, and have given occasion to the term sonorous *undulations.* In the air, in particular, so elastic as it is, the vibration must propagate itself, not only in the direction of the primitive concussion, but in all directions, in the same degree. The transmitted vibrations, we must observe, are always necessarily isochronal with the primitive vibrations, though their amplitude may be widely different.

It is clear from the outset that the science of acoustics becomes, almost from its origin, subject to the laws of rational mechanics. Since the time of Newton, who was the first to attempt to determine the rate of propagation of sound in the air, acoustics has always been more or less mixed up with the labor of geometers to develop abstract Mechanics. It was from simple considerations of acoustics that Daniel Bernouilli derived the general principle relating to the necessary and separate coexistence, or independency, of small and various oscillations occasioned at the same time in any system, by distinct concussions. The phenomena of sound afford the best realization of that law, without which it would be impossible to explain the commonest phenomenon of acoustics—the simultaneous existence of numerous and distinct sounds, such as we are every moment hearing.

Though the connection of acoustics with rational Mechanics is almost as direct and complete as that of Barology, this mathematical character is far less manageable in the one case than the other. The most important questions in barology are immediately connected with the clearest and most primitive mechanical theories; whereas the mathematical study of sonorous vibrations depends on that difficult and delicate dynamical theory, the theory of the perturbations of equilibrium, and the differential equations which it furnishes relative to the highest and most imperfect part of the integral calculus. Vibratory motion of one dimension is the only one, even in regard to solids, whose mathematical theory is complete. Of such motion of three dimensions we are, as yet, wholly ignorant.

To form any idea of the difficulties of the case, we must remember that vibratory motions must occasion certain physical modifications of another nature in the molecular constitution of bodies; and that these changes, though affecting the vibratory result, are too minute and transient to be appreciable. The only attempt that has been made to analyze such a complication is in the case of the thermological effects which result from the vibratory motion. Laplace used this case to explain the difference between the velocity of sound in the air as determined by experiment and that prescribed by the dynamic formula, which indicated a variation of about one-sixth. This difference is accounted for by the heat disengaged by the compression of the atmospheric strata, which must make their elasticity vary in a greater proportion than their density, thereby accelerating the propagation of the vibratory motion. It is true, a great gap is left here; since, as it is impossible to measure this disengagement of heat, we must assign to it conjecturally the value which compensates for the difference of the two velocities. But we learn from this procedure of Laplace the necessity of combining thermological considerations with the dynamical theory of vibratory motions. The modification is less marked in the case of liquids, and still less in that of solids; but we are too far behind with our comparative experiments to be able to judge whether the modification is or is not too inconsiderable for notice.

Notwithstanding the eminent difficulties of the mathematical theory of sonorous vibrations, we owe to it such progress as has yet been made in acoustics. The formation of the differential equations proper to the phenomena is, independent of their integration, a very important acquisition, on account of the approximations which mathematical analysis allows between questions, otherwise heterogeneous, which lead to similar equations. This fundamental property, whose value we have so often to recognise, applies remarkably in the present case; and especially since the creation of mathematical thermology, whose principal equations are strongly analogous to those of vibratory motion.—This means of investigation is all the more valuable on account of the difficulties in the way of direct inquiry into the phenomena of sound. We may decide upon the necessity of the atmospheric medium for the transmission of sonorous vibrations; and we may conceive of the possibility of determining by experiment the duration of the propagation, in the air, and then through other media; but the general laws of the vibrations of sonorous bodies escape immediate observation. We should know almost nothing of the whole case if the mathematical theory did not come in to connect the different phenomena of sound, enabling us to substitute for direct observation an equivalent examination of more favorable cases subjected to the same law. For instance, when the analysis of the problem of vibrating cords has shown us that, other things being equal, the number of oscillations is in inverse proportion to the length of the cord, we see that the most rapid vibrations of a very short cord may be counted, since the law enables us to direct our attention to very slow vibrations. The same substitution is at our command in many cases in which it is less direct. Still, it is to be regretted that the process of experimentation has not been further improved.

Divisions.

Acoustics consists of three parts. We might perhaps say four, including the *timbre* (ring or tone) arising from the particular mode of vibration of each resonant body. This quality is so real that we constantly speak of it, both in daily life and in natural history: but it would be wandering out of the department of general physics to inquire what constitutes the ring or tone peculiar to different bodies, such as stones, wood, metals, organized tissues, etc., whose properties lie within the scope of concrete physics. But, if we regard this quality as capable of modification by changes of circumstances, then we bring it into the domain of acoustics, and recognise its proper position, though we know nothing else about it. That part of the science presents a mere void.

The three parts referred to are, first, the mode of propagation of sounds: next, their degree of intensity; and thirdly, their musical tone. Of these departments, the second is that of which our knowledge is most imperfect.

SECTION I.

PROPAGATION OF SOUNDS.

Propagation of sounds.

As to the first, the propagation of sounds, the simplest, most interesting, and best known question is the measurement of the duration, especially when the atmosphere is the medium. Newton ennunciated it very simply, apart from all modifying causes;—that the velocity of sound is that acquired by a gravitating body falling from a height equal to half the weight of the atmosphere,—supposing the atmosphere homogeneous. In an analogous way, we may calculate the velocity of sound in the different gases, according to their respective densities and elasticities. By this law the speed of sound in the air must be regarded as independent of atmospheric vicissitudes, since, by Mariotte's rules, the density and elasticity of the air always vary in proportion; and their mutual relation alone influences the velocity in question. Of Laplace's rectification of Newton's formula, we took notice just now.—One important result of this law is the necessary identity of the velocity of different sounds, notwithstanding their varying degrees of intensity or of acuteness. If any inequality existed, we should be able to establish it, from the irregularity which must take place in musical intervals at a certain distance.

Effect of atmospheric agitation.

All mathematical calculations about the velocity of sound suppose the atmosphere to be motionless, except in regard to the vibrations under notice, and it is one of the interesting points of the case to ascertain what effect is produced by agitations of the air. The result of experiments for this purpose is that, within the limits of the common winds, there is no perceptible effect on the velocity of sound when the direction of the atmospheric current is perpendicular to that in which the sound is propagated; and that when the two directions coincide, the velocity is slightly accelerated if the directions agree, and retarded if they are opposed: but the amount and, of course, the law of this slight perturbation are unknown.—It is only in regard to the air that the velocity of sound has been effectually studied.

SECTION II.

INTENSITY OF SOUNDS.

Intensity of sounds.

We can not pretend to be any wiser about the intensity of sounds,—which is the second part of acoustics. Not only have the phenomena never been analyzed or estimated, but the labors of the student have added nothing essential to the results of popular experience about the influences which regulate the intensity of sound; such as the extent of vibrating surfaces, the distance of the resonant body, and so on. These subjects have therefore no right to figure in our programmes of physical science; and to expatiate upon them is to misconceive the character of science, which can never be anything else than a special carrying out of universal reason and experience, and which therefore has for its starting point the aggregate of the ideas spontaneously acquired by the generality of men in regard to the subjects in question. If we did but attend to this truth, we should simplify our scientific expositions not a little, by stripping them of a multitude of superfluous details which only obscure the additions that science is able to make to the fundamental mass of human knowledge.

With regard to the intensity of sound, the only scientific inquiry, —a very easy one,—which has been accomplished, relates to the effect of the density of the atmospheric medium on the force of sounds. Here acoustics confirms and explains the common observation on the attenuation of sound in proportion to the rarity of the air, without informing us whether the weakening of the sound is in exact proportion to the rarefaction of the medium, as it is natural to suppose. In my opinion, we know nothing yet of a matter usually understood to be settled,—the mode of decrease of sound, in proportion to the distance of the sounding body; as to which science has added nothing to ordinary experience. It is commonly supposed that the decrease is in an inverse ratio to the square of the distance. This would be a very important law if we could establish it: but it is at present only a conjecture; and I prefer admitting our ignorance to attempting to conceal a scientific void, by arbitrarily extending to this case the mathematical formula which belongs to gravitation. A natural prejudice may dispose us to find it again here; but we have no proof of its presence.

It would be strange if we had any notion of the law of the case, when we have not yet any fixed ideas as to the way in which intensity of sound may be estimated; nor even as to the exact meaning of the term. We have no instrument which can fulfil, with regard to the theory of sound, the same office as the pendulum and the barometer with regard to gravity, or the thermometer and electrometer with regard to heat and electricity. We do not even discern any clear principle by which to conceive of a *sonometer*. While the science is in this state, it is much too soon to hazard any numerical law of the variations in the intensity of sound.

SECTION III.

THEORY OF TONES.

Theory of Tones.

THE third department of acoustics,—the theory of tones,—is by far the most interesting and satisfactory to us in its existing state.

The laws which determine the musical nature of different sounds, that is, their precise degree of acuteness or gravity, marked by the number of vibrations executed in a given time, are accurately known only in the elementary case of a series of linear, even rectilinear vibrations produced either in a metallic rod, fixed at one end and free at the other, or in a column of air filling a very narrow cylindrical pipe. It is by a combination of experiment and of mathimatical theory that this case is understood. It is the most important for the analysis of the commonest inorganic instruments, but not for the study of the mechanism of hearing and utterance. With regard to stretched cords, the established mathematical theory is that the number of vibrations in a given time is in the direct ratio of the square root of the tension of the cord, and in the inverse ratio of the product of its length by its thickness. In straight and homogeneous metallic rods this number is in proportion to the relation of their thickness to the square of their length. This essential difference between the laws of these two kinds of vibrations is owing to the flexibility of the one sounding body and the rigidity of the other. Observation pointed it out first, and especially with regard to the effect of thickness. These laws relate to ordinary vibrations, which take place transversely; but there are vibrations in a longitudinal direction much more acute, which are not affected by thickness, and in which the difference between strings and rods disappears, the vibrations varying reciprocally to the length; a result which might be anticipated from the inextensibility of the string being equivalent to the rigidity of the rod. A third order of vibrations arises from the twisting of metallic rods, when the direction becomes more or less oblique. It ought to be observed however that recent experiments have shown that these three kinds are not radically distinct, as they can be mutually transformed by varying the direction in which the sounds are propagated. As for the sounds yielded by a column of air, the number of vibrations is in inverse proportion to the length of each column, if the mechanical state of the air is undisturbed; otherwise, it varies as the square root of the relation between the elasticity of the air and its density. Hence it is that changes of temperature which alter this relation in the same direction have here an action absolutely inverse to that which they produce on strings or rods: and thus it is explained by acoustics why it is impossible, as musicians have always found it, to maintain through a changing temperature the harmony at first established between stringed and wind instruments.

Thus far the resonant line has been supposed to vibrate through its whole length. But if, as usually happens, the slightest obstacle to the vibrations occurs at any point, the sound undergoes a radical modification, the law of which could not have been mathematically discovered, but has been clearly apprehended by the great acoustic experimentalist, Sauveur. He has established that the sound produced coincides with that which would be yielded by a similar but shorter cord equal in length to that of the greatest common measure between the two parts of the whole string. The same discovery explains another fundamental law, which we owe to the same philosopher—that of the series of harmonic sounds which always accompanies the principal sound of every resonant string, their acuteness increasing with the natural series of whole numbers; the truth of which is easily tested by a delicate ear or by experiment. The phenomenon is, if not explained, exactly represented by referring it to the preceding case; though we can not conceive how the spontaneous division of the string takes place, nor how so many vibratory motions, so nearly simultaneous, agree as they do.

Composition of sounds.

These are the laws of simple sound. Of the important theory of the composition of sounds we have yet very imperfect notions. It is supposed to be indicated by the experiment of the musician Tartini, with regard to resulting sounds. He showed that the precisely simultaneous production of any two sounds, sufficiently marked and intense, occasions a single sound, graver than the other two, according to an invariable and simple rule. Interesting as this fact is, it relates to physiology, and not to acoustics. It is a phenomenon of the nerves; a sort of normal hallucination of the sense of hearing, analogous to optical illusions.

The vibrations of resonant surfaces have exhibited some curious phenomena to observation, though the mathematical theory of the case is still in its infancy: and M. Savart's observations on the vibratory motions of stretched membranes must cast much light on the auditory mechanism, in regard to the effects of degrees of tension, the hygrometrical state, etc.

The study of the most general and most complicated case, that of a mass which vibrates in three dimensions, is scarcely begun, except with some hollow and regular solids. Yet this analysis is above all important, as without it it is clearly impossible to complete the explanation of any real instrument; even of those in which the principal sound is produced by simple lines, the vibrations of which must always be more or less modified by the masses which are connected with them. We may say that the state of acoustics is such that we can not explain the fundamental properties of any musical instruments whatever. Daniel Bernouilli worked at the theory of wind instruments; a subject which may appear very simple, but which really requires the highest perfection of the science, even putting aside those extraordinary effects, far transcending scientific analysis, which the art of a musician may obtain from any instrument whatever, and restricting ourselves to influences which may be clearly defined and durably characterized.

Imperfect as is our review of Acoustics, I hope we now understand something of its general character, the importance of its laws, as far as we know them, the connection of its parts, the development that they have obtained, and the intervals which are left void, to be filled up by future knowledge.

CHAPTER V.

OPTICS.

Hypothesis on the nature of Light.

The emancipation of natural philosophy from theological and metaphysical influence has thus far gone on by means of a succession of partial efforts, each isolated in intention, though all converging to a final end, amid the entire unconsciousness of those who were bringing that result to pass. Such an incoherence is a valuable evidence of the force of that instinct which universally characterizes modern intelligence; but it is an evil, in as far as it has retarded and embarrassed and even introduced hesitation into the course of our liberation. No one having hitherto conceived of the positive philosophy as a whole, and the conditions of positivity not having been analyzed, much less prescribed, with the modifications appropriate to different orders of researches, it has followed that the founders of natural philosophy have remained under theological and metaphysical influences in all departments but the one in which they were working, even while their own labors were preparing the overthrow of those influences. It is certain that no thinker has approached Descartes in the clearness and completeness with which he apprehended the true character of modern philosophy; no one exercised so intentionally an action so direct, extensive, and effectual, on this transformation, though the action might be transitory; and no one was so independent of the spirit of his contemporaries; yet Descartes, who overthrew the whole ancient philosophy about inorganic phenomena, and the physical phenomena of the organic, was led away by the tendency of his age in a contrary direction, when he strove to put new life into the old theological and metaphysical conceptions of the moral nature of man. If it was so with Descartes, who is one of the chief types of the progress of the general development of humanity, we can not be surprised that men of a more special genius, who have been occupied rather with the development of science than of the human mind, should have followed a metaphysical direction in some matters, while in others not very remote they have manifested the true positive spirit.

These observations are particularly applicable to the philosophical history of Optics—the department of Physics in which an imperfect positivism maintains the strongest consistence—chiefly through the mathematical labors which are connected with it. The founders of this science are those who have done most toward laying the foundations of the Positive Philosophy—Descartes, Huyghens, and Newton; yet each one of them was led away by the old spirit of the absolute to create a chimerical hypothesis on the nature of light. That Newton should have done this is the most remarkable, considering how his doctrine of gravitation had raised the conception of modern philosophy above the point at which Descartes had left it, by establishing the radical inanity of all research into the nature and mode of production of phenomena, and by showing that the great end of scientific effort is the reduction of a system of particular facts to one singular and general fact. Newton himself, whose favorite saying was, "O! Physics, beware of Metaphysics!" allowed himself to be seduced by old habits of philosophizing to personify light as a substance distinct from and independent of the luminous body: a conception as metaphysical as it would have been to imagine gravity to have an existence separate from that of the gravitating body.

After what has been said about the philosophical theory of hypotheses, there can be no occasion to expose the fictitious character of the respective doctrines of philosophers on the nature of light. Each one has exposed the untenableness of those of others; and each explorer has confined himself to the evidence which favored his own conception. Euler brought fatal objections against the doctrine of emission; yet, at the present day, our instructors conceal the fact that the advocates of the emission doctrine have offered equally fatal objections to that of undulations. To take the most simple instance—Has the fact of propagation in all directions, characteristic of the vibratory motion, ever been reconciled with the common phenomenon of night; that is, of darkness produced by the interposition of an opaque body? Does not the fundamental objection of the Newtonians about this matter hold its ground against the system of Descartes and Huyghens, untouched at this hour as it was above a century ago, after all the subterfuges that have been in use ever since? The case is made clearer by the fact that there are phenomena which the two theories will suit equally well. If the laws of reflection and refraction issue with equal ease from the hypotheses of emission and undulation, it is pretty clear that our business is with the laws, and not with the hypotheses. The mathematical labors expended on the opposite theories will not have been thrown away; they will show, in a very short time, that the analytical apparatus is no certain instrument of truth, as it has served the purpose of both hypotheses equally well; as it would, quite as easily, of many others, if the progress of positivity was not excluding, more and more, this vicious method of philosophizing. It is true, the most enlightened advocates of both systems are ready to give up the reality of emission and of undulation, and hold to them only as a matter of logical convenience—as a rallying-point of ideas. But if we can pass from the one hypothesis to the other without affecting the science at all, it is clear that such an artifice is needless. We must admit, as we before said, that the combination of scientific ideas would be extremely difficult to minds trained under the prevalent habits of thought, if they were suddenly deprived of such a mode of connection as they here contend for; but it is not the less true that the next generation of scientific thinkers would combine their ideas more easily, and much more perfectly, if they were trained to regard directly the relations of phenomena, without being troubled by artifices like these, which only obscure scientific realities.

The history of Optics, regarded as a whole, seems to show that these hypotheses have not sensibly aided the progress of the theory of light, since all our important acquisitions have been entirely independent of them. This is true not only of the laws of reflection and refraction, which were discovered before these hypotheses were created, but with regard to all the other leading truths of Optics. The hypothesis of emission no more suggested to Newton the notion of the unequal refrangibility of the different colors, than that of undulation disclosed to Huyghens the law of double refraction proper to certain substances. Great discoverers like these observe a connection of facts, and then create an hypothesis to account for the connection; and then those who come after them conclude that the chimerical conceptions must be inseparable from the immortal discoveries. There is a use, as I have before asserted, in these imaginary conceptions, which, in regard to their one function, are indispensable. They serve, transiently, to develop the scientific spirit by carrying us over from the metaphysical to the positive system. They can do this and nothing more, and they accomplished their task some time ago. Their action can henceforth be only injurious, and especially in the case of Optics, as any one may see who will inquire into the state of this science—particularly since the almost universal adoption of the undulatory in the place of the emissive system.

Excessive tendency to systemize.

One more error must be noticed before we leave the subject of the unscientific pursuit of Optics. Some enlightened students imagine that the science acquires a satisfactory rationality by being attached to the fundamental laws of universal mechanics. The emission doctrine, if it means anything, must suppose luminous phenomena to be in analogy with those of ordinary motion; and if the doctrine of undulation means anything, it means that the phenomena of light and sound are alike in their vibratory agitation; and thus the one party likens optics to barology and the other to acoustics. But not only is nothing gained by the supposition, but if either was the case, there would be no room for imagination or for argument. The connection would be at once apparent to all eyes on the simple view of the phenomena. Such a reference of phenomena to those general laws has never been a matter of question or of conjecture. The only difficulty has been to know those laws well enough to admit of the application. No one doubted the mechanical nature of the principal effects of gravity and sound long before the progress of rational dynamics admitted of their exact analysis. The application powerfully tended, as we have seen, to the perfecting of barology and acoustics; but this was precisely because there was nothing forced or hypothetical about it. It is otherwise with Optics. Notwithstanding all arbitrary suppositions, the phenomena of light will always constitute a category *sui generis*, necessarily irreducible to any other: a light will be for ever heterogeneous to a motion or a sound.

Again, physiological considerations discredit this confusion of ideas, by the characteristics which distinguish the sense of sight from those of hearing, and of touch or pressure. If we could abolish such distinctions as these by gratuitous hypotheses, there is no saying where we should stop in our wanderings. A chemical philosopher might make a type of the senses of taste and smell, and proceed to explain colors and tones by likening them to flavors and scents. It does not require a wilder imagination to do this, than to issue as a supposition, now become classical, that sounds and colors are radically alike. It is much better to leave such a pursuit of scientific unity, and to admit that the categories of heterogeneous phenomena are more numerous than a vicious systemizing tendency would suppose. Natural philosophy would, no doubt, be more perfect if it were otherwise; but co-ordination is of no use unless it rests on real and fundamental assimilation. Physicists must then abstain from fancifully connecting the phenomena of light and those of motion. All that Optics can admit of mathematical treatment is with relation, not to mechanics, but to geometry, which is eminently applicable to it, from the evidently geometrical character of the principal laws of light. The only case in which we can conceive of a direct application of analysis is in certain optical researches in which observation would immediately furnish some numerical relations; and in no case must the positive study of light give place to a dynamical analysis. These are the two directions in which geometers may aid the progress of Optical science, which they have only too effectually impeded by prolonging the influence of anti-scientific hypotheses through inappropriate and ill-conceived analyses.

The genius of Fourier released us from the necessity of applying the doctrine of hypotheses, as previously laid down, to the case of thermology; and neither barology nor acoustics required it. As to electrology, there are abundance of chimerical conceptions preponderant in that department; but their absurdities are so obvious, that almost all their advocates acknowledge them. It is in Optics that the plausibility and consistence of such chimeras give them the most importance; and I have therefore chosen that department as the ground on which they should be judged.

We will now pass from these useless hypotheses to the real knowledge that we are in possession of about the theory of light. The whole of Optics is naturally divided into four departments, as light, whether homogeneous or colored, is direct, reflected, refracted, or diffracted. These elementary ef-

Divisions of Optics.

fects usually co-exist in ordinary phenomena; but they are distinct, and must therefore be separately considered. These four parts comprehend all optical phenomena which are rigorously universal; but we must add, as an indispensable complement, two other sections, relating to double refraction and polarization. These orders of phenomena are proper to certain bodies; but, beside that, they are a remarkable modification of fundamental phenomena, they appear in more and more bodies, as the study proceeds, and their conditions refer more to general circumstances of structure than to incidents of substance. For these reasons they ought to be exactly analyzed. As for the rest, it is not our business to classify the application of these six departments either to natural history, as in the beautiful Newtonian theory of the rainbow, or to the arts, as in the analysis of optical instruments. These applications serve as the best measure of the degree of perfection of the science; but they do not enter into the field of optical philosophy, with which alone we are concerned.

Irrelevant matters.

Theory of vision.

For the same reasons which have led us to condemn theories of hearing and utterance, in connection with Physics, we must now refuse to include among optical phenomena the theory of vision, which certainly belongs to physiology. When physicists undertake the study of it, they bring only one of the special qualifications necessary, being otherwise on a level with the multitude; and, however important their one qualification may be, it cannot fulfil all the conditions. It is in consequence of so many conditions being unfulfilled, that the explanations hitherto offered have been so incomplete, and therefore illusory. There is scarcely a single law of vision which can be regarded as established on a sound basis, even where the simplest and commonest phenomena are in question. The elementary faculty of seeing distinctly at unequal distances remains without any satisfactory explanation, though physicists have attempted to refer it to almost every part of the ocular apparatus in succession. This humbling ignorance is no doubt owing to scientific men, both physiologists and physicists, having left the theory of sensations in the hands of the metaphysicians, who have got nothing out of it but some deceptive ideology; but before this time we should have approached to something like positive solutions, but for the bad organization of scientific labor among us. If, from the time of these questions beginning to assume a positive character, anatomists and physiologists had occupied themselves with a theory of vision grounded on the materials furnished by Optical science, instead of looking to physicists for solutions which they could not furnish, our condition in regard to this important subject would be somewhat less deplorable than it is.

Specific Color of Bodies.

Another study which must be excluded from Optics, and from all natural philosophy, is the theory of the color of bodies. I need not explain that I am not referring to the admirable Newtonian experiments on the decomposition of light, which have supplied a fundamental idea, common to all the departments of Optics.

I refer to the attempts made to ascertain, now through the theory of emission, and now through that of undulation, the inexplicable primitive phenomenon of the elementary color proper to every substance. The so-called explanations, about the supposed faculty of reflecting or transmitting such and such a kind of rays, or of exciting such and such an order of ethereal vibrations, in virtue of certain supposed derangements of the molecules, are more difficult to conceive than the fact itself, and are, in truth, as absurd as the explanations that Molière puts into the mouth of his metaphysical doctors. It is lamentable that we should have such comments to make in these days. Nobody now tries to explain the specific gravity proper to any substance or structure: and why should we attempt it with regard to specific color, which is quite as primitive an attribute? In physiology, the consideration of colors is of high importance, in connection with the theory of vision; and in natural history, it may prove a useful means of classification: but, in optics, the object of the true theory of colors is merely to perfect the analysis of light, so as to estimate the influence of structure or other circumstance upon transmitted or reflected color, without entering into the causes of specific coloring. The field of inquiry is vast enough, without any such illusory research as this.

SECTION I.

STUDY OF DIRECT LIGHT.

Optics proper.

THE first department is that of Optics, properly so called, or the study of direct light. This and catoptrics are the only part of the science cultivated by the ancients; but this branch is as old as the knowledge of the law of the rectilinear propagation of life in every homogeneous medium. This primary law makes purely geometrical questions of problems relating to the theory of shadows; questions difficult to manage in many cases, but not in the most important,—those of very distant luminous bodies, or bodies of extremely small dimensions. The theory depends, both for the shadow and the penumbra, on the determination of an extensible surface, circumscribed at once by the luminous and the illuminated body.—Whatever its real antiquity may be, this first part of Optics is still very imperfect, regarded from the second point of view; that is, with regard to the laws of the intensity of light, or what is called *photometry*. Important as it is to have a clear knowledge, our notions are as yet either vague or precarious as to how the intensity of light is modified by such circumstances as its direction, whether emergent or incident; its distance; its absorption by the medium; and, finally, its color.

Imperfections.

Photometry.

We are met by a grand difficulty at the outset. We have no photometrical instruments that can be depended on for enabling us to verify our conjectures on the different modes of gradation of light. All our photometers rest on a sort of vicious circle, being devised in accordance with the laws which they are destined to verify, and generally according to the most doubtful of all, in virtue of its metaphysical origin,—that which relates to distance. We have called light an emanation; have calculated its intensity by the square of its distance: and then, without confirming this conjecture by any experiment whatever, we have proceeded to found the whole of photometry upon it. And when this conjecture was replaced by that of undulations, we accepted the same photometry, neglecting the consideration that it must require revision from its very basis. It is clear what our present photometry must be, after such treatment as this. The law relating to direction, in the ratio of the sine of the angle of emergence or of incidence, is no better demonstrated than that of distance, though it comes from a less suspicious source. It has nothing about it at present like Fourier's labors on radiating heat; and yet it seems as if it would admit of an analogous mathematical elaboration. The only part of photometry which has, as yet, any scientific consistency is the mathematical theory of gradual absorption of light by any medium. Bouguer and Lambert have given us some interesting knowledge about this: but even here we are on unstable ground, for want of precise and unquestionable experiments. Again, the photometrical influence of color has been the subject of some exact observations; but we are not yet in possession of general and precise conclusions, unless it be the fixing of the maximum of brightness in the middle of the solar spectrum. Thus, to sum up, in this first, oldest, and simplest department of optics, philosophers have scarcely outstripped popular observation,—leaving out what belongs to geometry, and the measurement of the velocity of the propagation of light, which is furnished by astronomy.

SECTION II.

CATOPTRICS.

It is otherwise with regard to catoptrics, and yet mare, dioptrics, if we discard questions about the first causes of reflection and refraction. Scientific studies have largely extended and perfected universal ideas about those two orders of general phenomena; and the varied effects belonging to them are now referred with great precision to a very small number of uniform laws, of remarkable simplicity.

Great law of reflection.

The fundamental law of catoptrics, well known by the ancients, and abundantly confirmed by experiment, is, that whatever may be the form and nature of the reflecting body, and the color and intensity of the light, the angle of reflection is always equal to the angle of incidence, and in the same normal plane. Under this law, the analysis of the effects produced by all kinds of mirrors is reduced to simple geometrical problems, which might, it is true, involve some long and difficult calculations, according to the forms of some bodies, if it were not usually sufficient to examine the simple forms of the plane, the sphere, and, at most, the circular cylinder. If we pretended to absolute precision in the analysis of images, we might encounter considerable geometrical difficulties: but this is not necessary. This analysis depends, in general, mathematically speaking, on the theory of *caustic curves*, created by Tschirnhausen. But even in the application of this theory, some conjectures are hazarded; and the want of direct and exact experiments, and the uncertainty which attends almost all the parts of the theory of vision, prevents our depending too securely on the reality of the remote results of any general principle that we can yet employ.

Laws of absorption not found.

Every luminous reflection upon any body whatever is accompanied by an absorption of more or less, but always of a great part of the incident light; and this gives rise to a second interesting question in catoptrics. But our knowledge about it amounts to very little, from our backwardness in photometry; so that we have not yet laid hold of any law. We do not know whether the loss is the same in all cases of incidence: nor whether it is connected with the degree of brightness: nor what is the influence of color upon it: nor whether its variations in different reflecting bodies are in harmony with other specific, and especially optical characters. These questions are not only untouched—they have never been proposed. All that we know is simply that the absorption of light appears to be always greater (but to what degree we are ignorant) by reflection than by transmission. From this has resulted, in recent times, the use of lenticular beacons, introduced by Fresnel.

A more advanced kind of inquiry belongs to the study of transparent substances; but here, again, the laws are ill understood. In these bodies, reflection accompanies refraction, and we have the opportunity of inquiring by what laws, general or special, the division between transmitted and reflected light takes place. We only know that the last is more abundant in proportion as the incidence is more oblique: and that reflection begins to become total from a certain inclination proper to each substance, and measured exactly with regard to several bodies. The inclination appears to be less in proportion as the substance is more refracting; but the supposed law of the case is connected with chance conjectures upon the nature of light, and requires to be substantiated by direct experiment.

SECTION III.

DIOPTRICS.

Great law of refraction.

Of all the departments of Optics, dioptrics is at present the richest in certain and exact knowledge, reduced to a few simple laws, embracing a large variety of phenomena. The fundamental law of refraction was wholly unknown to the ancients, and was discovered at the same time, under two distinct and equivalent forms, by Snellius and Descartes. It consists of the constant proportion of the sines of the angles that the refracted ray and the incident ray, always contained in the same normal plane, form with the perpendicular to the refracting surface, in whatever direction the refraction may be. The fixed relation of these two sines, when the light passes from a vacuum into any medium whatever, constitutes the most important optical co-efficient of every natural body, and holds a real rank in the aggregate of its physical characteristics. The philosophers have labored at its determination with much care and success, by ingenious and exact processes; they have prepared very extensive tables, which may rival, as to precision, our tables of specific gravity—the uncertainty not exceeding a hundredth part of the numerical value of the refracting power. If the light passes from one medium to another, the relation of the refraction depends on the nature of both; but in every case, the inverse passage gives it always a precisely reciprocal value, as experiment has constantly shown. Again, while a body undergoes no chemical change, and becomes only more or less dense, the relation of refraction which belongs to it varies in proportion to the specific gravity; as may be easily shown, especially with regard to liquids, and yet more to gases, in which we can so extensively modify density by temperature and pressure. This is why philosophers have adopted, in preference to the proper relation of refraction, its quotient by the density, which they have named refracting power; in order to obtain more fixed and specific characters in the dioptric comparison of different substances. There is substantial ground for this distinction, though its origin was suspicious. But it must be observed that the refracting power varies when the substance does not undergo any chemical change, but passes, as we have seen in the case of water, through different states of aggregation. These variations in the refracting power have given occasion to conflicts between the advocates of the two hypothetical systems—each of which requires an invariability in the refracting power which we do not know to exist; and the difficulty of separating what is really established from what they require is one of the mischievous consequences of anti-scientific hypotheses, and one which may well render the actual character of the science itself doubtful to impartial minds.

Newton's discoveries on elementary colors.

Newton's discoveries of the unequal refrangibility of the different elementary colors form an indispensable complement of the law of refraction. From the fact of the decomposition of light in a prism, it clearly follows that the relation of the sine of incidence, though constant for each color, varies in the different portions of the solar spectrum. The total increase which it undergoes from the red rays to the violet measures the *dispersion* proper to each substance, and must complete the determination of its refracting [power in the common tables, where only the mean refraction can be inserted. This estimate constitutes, from its minuteness, one of the most delicate operations of optics, and does not admit of so much exactness as that of the refracting action properly so called, especially in bodies which bend the light but little, as the gases; but it is ascertained for a considerable number of substances, solid or liquid. In comparing the changes of the dispersive power as we pass from one body to another, we discover that the variations are not, as Newton supposed, in proportion to the refracting power; and indeed we find, in more than one case, that the light is least dispersed by substances which refract it most. The discovery of this discrepancy between two qualities which appear to be analogous, was made by Dollond, about the middle of the last century. It is an idea of high importance in Optics, as it indicates the possibility of achromatism by the compensation of the opposite action pertaining to two different substances which, without that, could not cease to disperse the light but by ceasing to bend it.

The laws of refraction show us that there can be none but purely geometrical difficulties in the analysis of the effects of homogeneous media upon the light which traverses them. The great complication which might arise from the form of the refracting body is diminished in ordinary cases by our satisfying ourselves with plane, spherical, or cylindrical surfaces; but we should yet find the inquiry embarrassing, and especially in regard to the dispersion, if we did not confine it to an approximate estimate of the few commonest circumstances.

SECTION IV.

DIFFRACTION.

The modification called diffraction has now become one of the essential parts of Optics. It was entered upon by Grimaldi and Newton, advanced by the researches of Dr. Young, and completed by those of Fresnel. It consists of the deviation, always accompanied by a more or less marked dispersion, that light undergoes, in passing close by the edges of any body or opening. Its simplest way of manifesting itself is by the unequal and variously-colored fringes, some exterior and some interior, which surround the shadows produced in a darkened room. The famous general principle of *interferences*, discovered by Dr. Young, is the most important idea connected with this theory. It was not appreciated, remarkable as it is, till Fresnel made use of it to explain several interesting phenomena, difficult to analyze; and, among others, the celebrated phenomenon of the colored rings, which were by no means fully accounted for by Newton's admirable efforts. The law of interferences is this: that when two luminous cones emanate from the same point, and follow, for any reason, two distinct courses, but little inclined toward each other, the intensities proper to the two lights neutralize and augment each other alternately, increasing by equal and minute degrees, the value of which is determined, by the difference in length between the entire paths traversed by the two cones. It is a pity that this important principle should have suffered, like the rest, from being implicated with chimerical conceptions on the nature of light.

We have done all that the nature of this work admits, in regard to Optics; and we must pass over the subjects of the double refraction proper to various crystals, the general law of which was discovered by Huyghens. We must also omit the phenomena of *polarization*, disclosed by Malus. In what I have brought forward, I hope that, while I have pointed out the gaps in this science, of which we are too little conscious at present, I have also placed in a clear light the great and numerous results obtained during the last two centuries, notwithstanding the disastrous preponderance of vain hypotheses about the nature of light over the spirit of rational experimentation.

CHAPTER VI.

ELECTROLOGY.

History.

This last branch of Physics, relating as it does to the most complex and least manifest phenomena, could not be developed till after the rest. The electrical machine indeed is as old as the air-pump; but it was not till a century later that the study assumed a scientific character, through the distinction of the two electricities, Muschenbroek's experiments with the Leyden jar, and then through Franklin's great meteorological discovery, which was the first manifestation of the influence of electricity in the general system of nature. Up to that time, the isolated observations of philosophers had only suggested the character of generality inherent in this part of Physics, as in all others, by continually adding to the number of substances susceptible of electrical phenomena; and it was not till the end of the last century that this department of Physics presented anything like the rational character which belongs to the others. It is owing to the labors of Coulomb that it takes its place, and still an inferior place, with the rest.

Condition.

No other science offers so great a variety of curious and important phenomena; but facts do not constitute science, though they are its foundation and material. Science consists in the systemizing of facts under established general laws; and, regarded in this way, Electrology is the least advanced of all the branches of Physics, imperfect as they all are. In the absence of ascertained laws, arbitrary hypothesis has run riot. The simple confidence with which students have explained all phenomena by endowing imaginary fluids with new properties for every fresh occurrence, reminds us of the old metaphysical explanations—the ancient entities being merely replaced by supposed fluids. But the delusion is less mischievous here than

Arbitrary hypotheses.

in Optics, where the arbitrary conjectures are closely connected with real laws, and share their imposing character. In electrology the hypotheses, standing alone, exhibit their barrenness; and everybody can see that they have borne no share in the great discoveries of the last half-century, though the discoveries, once made, have been afterward attached to the hypotheses. Most people regard them now as a sort of mnemonic apparatus, useful for connecting facts in the memory, though originally designed for a very different purpose. They are a bad apparatus for even this object, which would be much better answered by a system of scientific formulas especially adapted to that use. And, though less mischievous than in Optics, hypotheses of this order do harm in electrology, as everywhere else, by concealing from most minds the real needs of the science. It should be remembered, moreover, that anti-scientific action like this extends its influence over the succeeding and more complex sciences, which, on account of their greater difficulty, require the severest method, the type of which will naturally be looked for in the antecedent sciences. It is a serious injury to transmit to them a radically vicious model. While physicists are using these hypotheses as having avowedly no intrinsic reality, their very use leads students of the successive sciences, and especially physiologists, to consider them the very sublimity of physics, and to proceed to take them for the bases of their own labors. We see how the notion of magnetic and electric fluids tends to confirm that of a nervous fluid, and to encourage wild dreams about the nature of what is called animal magnetism, in which even eminent physicists have shared. Such consequences show how a study which is naturally favorable to the positive development of human intelligence may, by vicious methods of philosophizing, become fatal to our understandings.

Relation to Mathematics.

From the complex nature of the phenomena, there can be but little application of mathematics in electrology. It has as yet borne only a small share in the progress of the science: but it is as well to point out the two ways,—the one illusory, the other real,—in which the application of mathematics has been attempted.

Unsound application

Those who have occupied themselves with imaginary fluids as the causes of electrical and magnetic phenomena, have transferred the general laws of rational mechanics to the mutual action of their molecules; thus making the body under notice a mere *substratum*, necessary for the manifestation of the phenomenon, but unconcerned in its production; with which office the fluid is charged. It is clear that mathematical labors, so baseless, can serve no other purpose than that of analytical exercise, without adding a particle to our knowledge. In the other case,—of a sound application,—the mathematical process has been based on some general and elementary laws, established by experiment, according to which the study of phenomena proper to the bodies themselves has been pursued,—all chimerical hypotheses

Sound application.

being discarded. This is the character of the able researches of M. Ampère and his successors, on the mathematical investigation of electro-magnetic phenomena, in which the laws of abstract dynamics have been efficaciously applied to certain cases of mutual action between electric conductors or magnets.

In examining the principal parts of electrology, we must exclude all that belongs to the chemical or physiological influence of electricity, and all connection of electricity with concrete physics; and especially with meteorology.

Divisions.

Thus limited to the physical and abstract, electrology at present comprehends three orders of researches. The first relates to the production, manifestation, and measurement of electrical phenomena: the second, to the comparison of the electric state proper to the different parts of the same mass, or to different contiguous bodies: the third, to the laws of the motions which result from electrization: we may add, as a fourth head, the application of the results under the other three to the special study of magnetic phenomena, which can never henceforth be separated from them.

SECTION I.

ELECTRIC PRODUCTION.

THE sum of our observations leads us to regard the electric condition of bodies as being, more or less evidently, an invariable consequence of almost all the modifications they can undergo: but the chief causes of electrization offer themselves, in the order of their power and scientific importance, thus: chemical compositions and decompositions: variations of temperature: friction: pressure: and, finally, simple contact. This distribution differs widely from that first indicated by inquiry,—friction being long supposed the only, and then the most powerful means of producing the electric condition. The comparison of means is very far from being exhausted; but we may be assured that the order specified above will never be radically changed.

Causes of electrization.

Chemical action.

There is no doubt that chemical actions are the most general sources of electricity, as well as the most abundant; as they are with regard to Heat. In the most powerful electrical apparatus, and especially in the Voltaic pile, the chemical action which at first passed unnoticed, is now recognised, thanks to the labors of Wollaston and others, as the principal source of electrization, which becomes indeed almost insensible when care is taken to exclude chemical action.—After this, the next most powerful cause is thermological action, though, till recently, it was recognised only in the single case of heated tourmalin. We now know that marked differences of temperature between consecutive bars of different kinds, whether homogeneous or otherwise in the particular case, suffice to induce a marked electrical condition, the more intense as the elements are more numerous.

Thermological action.

—the thermometrical conditions remaining the same.—These two causes are so powerful, and so difficult to exclude, that the estimate of the others becomes a very delicate matter. It is difficult to determine how much influence to ascribe to any cause after these two, while yet they are almost unavoidably present. Thus, even about friction, which used to be regarded as so powerful a cause, it is now doubtful whether the friction itself has any influence, and whether the electrization is not due to the thermometrical, and even the chemical effects which always accompany friction, but which always used to be overlooked in this instance.

Friction.

The case is nearly the same with Pressure, the electric influence of which however is, if less marked, more unquestionable, from our being able to isolate it more. But the remark is above all applicable to the production of the electric state by the simple contact of heterogeneous bodies. It was by this contact that Volta brought out the power of his wonderful instrument, while it is well known now that chemical action bears a chief part in it, and that contact contributes to it in only a secondary manner, if even it be not altogether doubtful.

Pressure.

Contact.

Besides these leading causes of electrization, there are many less important,—as changes in the mode of aggregation, the fusion of solids, and the evaporation of liquids. Even simple motion suffices, under special conditions, to induce an electric state, as M. Arago has shown in the experiment of the influence of the rotation of a metallic disk upon a magnetized needle, near but not contiguous. Our philosophers however must beware of passing into the other extreme from that with which they justly reproach their predecessors. It is, no doubt, prejudicial to electrology to neglect all sources of electrization but the most conspicuous: but it may not be less so to carry analysis too far, and see causes of electrization in all sorts of minute phenomena.*

Other causes.

A special instrument, or class of instruments, naturally corresponds to each of the general modes of electrization, in order to realize the most favorable conditions for the production and support of the electric state. However important these may be, it is clear that we can not here enter upon the consideration of them. But we must not pass over the instruments invented for the manifestation and measurement of the electric condition,—the electroscope and the electrometer. The most eminent philosophers have always attached the highest importance to the perfecting of these instruments, in the invention of which real genius has often been exhibited. Their perfection is of more consequence than that of electric producers; because very weak electric powers often answer best in delicate experiments, from their simplicity; while the utmost ingenuity is required in instituting means of manifesting and measuring the minutest electric effects.—

Instruments.

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* In this paragraph, M. Comte alludes to the now most fertile, but when he wrote the comparatively unknown subject of the development of Electricity by Induction.—J. P N.

Though the electric condition can not be measured without being first manifested, and the manifestation leads to some sort of estimate, there is a real distinction between electroscopes and electrometers. Among simple electroscopes, the most remarkable for use in very delicate researches, is that kind called *condensers*, which render feeble electrical effects sensible through their gradual accumulation: and all these instruments are so arranged as to show, by the method of experimentation itself, the positive or negative character of the electricity under notice.—Coulomb's electrical balance is certainly the most perfect of electrometers. It was by its means that he discovered, and that we every day demonstrate, the fundamental law of the variation of electric action, repulsive or attractive, inversely to the square of the distance; a law which could not be unquestionably obtained by any other means. As we have advanced in the science of electro-magnetism, a new class of electrometers has been introduced, for purposes of measurement, for which Coulomb's balance would not answer. These are the class of *multipliers*. Valuable and delicate as they are, they have not yet been applied, with so much certainty as the balance, to exact measurements, from the difficulty of proportioning the graduation to the intensity of the observed phenomenon.

SECTION II.

ELECTRICAL STATICS.

THE second part of electrology includes what is improperly called *electrical statics:* a term imputable to illusory hypotheses about the nature of electricity: yet it is not a wholly absurd title, as it relates, in fact, to the distribution of electricity in a mass, or in a system of bodies, the electric state of which is regarded as invariable. We may therefore continue to use this abridged term, if we carefully keep clear of all mechanical notions of the equilibrium of any supposed electric fluid, and attach to it a sense analogous to that of Fourier, when he spoke of an equilibrium of heat, and of economists when they speak of an equilibrium of population.

Great law of distribution.

Considering first the case of an isolated body, Coulomb has established a fundamental law which is (metaphorically expressed) the constant tendency of electricity to the surface, or, in rational language, that after an inappreciable instant of time electrization is always limited to the surface, however it may have been in the first place produced. As for the distribution of the electric state among the different parts of the surface, it depends on the form of bodies, being uniform for the sphere alone, unequal for all other forms, but always subject to regular laws. The analysis of these may be supposed to present insurmountable difficulties; nevertheless, Coulomb has established a general fact of great importance, by comparing the electric states proper to the extremities of an ellipsoid gradually elongated: he has perceived that their electrization increases rapidly as the figure is elongated, diminishing in the rest of the body; whence he deduced an explanation of that remarkable power of points, disclosed by Franklin.*

Electric equilibrium.

The laws of electric equilibrium between several contiguous bodies afford a yet more difficult and extensive inquiry. Coulomb studied them only in the limited and insufficient single case of spherical masses. However we learn from his labors that the nature of substances exercises no influence over the electric distribution established among them, the mode depending merely on their form and their magnitude; only, the electric state assumed by each surface is more or less persistent, and manifests itself with more or less rapidity, according to the degree of conductibility in the body. Coulomb analyzed completely the mutual action of two equal spheres; discovering that the electric condition is always null and the point of contact, scarcely sensible at 20 degrees from that point, fast increasing from 60 to 90 degrees, and then more slowly increasing up to 180 degrees, which is its maximum. If the globes are unequal, the smallest is the most strongly affected: and it makes no difference whether they are electrized together, or the one before the other. The question becomes more complex when more than two bodies are concerned. Coulomb examined only a series of globes ranged in a straight line; but if they had been so placed as that each should touch three or four others, the mode of electric distribution would inevitably have undergone great changes. The subject must be regarded as merely initiated by this great philosopher; and no one has added anything to it since his time. It offers to electricians a subject of almost inexhaustible research.†

SECTION III.

ELECTRICAL DYNAMICS.

Ampère's experiments.

THE third part of electrology is very properly called Electrical Dynamics, because it relates to the motions which result from electrization. Recent as is its origin, it is superior to the others in its scientific condition, through the labors of M. Ampère; always supposing conjectures about the nature of electric phenomena to be discarded. M. Ampère has referred the analysis of the effects observed in this branch of electrology to one great and general phenomenon, the laws of which he has fully ascertained; the direct and mutual action of two threads, charged with electricity by Voltaic piles, habitually reduced to their greatest simplification; that is, almost always composed of a single element.

M. Ampère so arranged his experiment as to guard the conducting threads from the perturbing influence of the earth's electricity, and this done, he could easily seize the elementary laws of the phenomenon under his notice. He found that when the two con ductors are sufficiently mobile, they tend to place themselves in directions parallel to each other; and that they then attract or repel each other, according to the conformity or contrariety of the two electric currents. In looking for the laws of the case, it is necessary, for the sake of generality and simplicity, to keep in view only infinitely small portions of the different conductors. These laws, mathematically considered, relate either to the influence of the direction, or to that of the distance.

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* Much has since been added to this class of investigations.—J. P. N.

† These specific facts are now comprehended within general laws.—J. P. N.

As to the direction, there are the two cases to be considered of the conducting elements being in the same plane, or in different planes. In the first case, the intensity of the action depends only on the angle formed by each of the two elements with the line which joins their middle points: it is null at the same time with this angle, and increases with it, attaining its maximum when it becomes right. All phenomena, direct or indirect, appear to be exactly represented if this intensity is made to vary in proportion to the sine of the inclination, according to the formula adopted by all the successors of M. Ampère. In the other case,—of the conductors not being in the same plane,—the action depends moreover on the mutual inclination of the planes indicated by each of them, and by the common line of their middle points; and the result of this second relation is wholly different. The perpendicularity of the two planes determines the absence of all action: there is attraction while the angle is acute, and it increases as the angle diminishes, its *maximum* taking place at the moment of coincidence; when the angle is obtuse, the action becomes repellent, and increases as each plane approaches toward the prolongation of the other, a situation which produces the *maximum* of repulsion. The supposition which arises in this case is that the action is in proportion to the cosine of the angle of the two planes; but we have not yet attained such certainty as in the former case.

As for the influence of distance, M. Ampère supposed that, in analogy with Coulomb's law of common electric attraction and repulsion, the action of two conducting elements is always reciprocal to the square of the distances of their middle points. But analogy is not sufficient to conclude upon; and direct observation is out of the question when the parts taken are infinitely small, and the result sought must be affected by the form and magnitude of the conductors. However, it may be mathematically demonstrated that, in the hypothesis adopted by M. Ampère, the action of a rectilinear conductor, of an indefinite length, upon a magnetized needle, must vary exactly in the inverse ratio of their shortest distance. This consequence has been precisely verified by experiment; and it places beyond a doubt the reality of the proposed law.

Under this law, electric action would seem to be, mathematically, in analogy with that of gravitation. But this case affords a lesson against incaution in transferring to the study of these singular movements the ordinary procedure of abstract dynamics. Gravitation is independent of mutual direction, which is the determining influence in electrical dynamics: and thus the parallel fails. We see, further, how many more difficulties are in the way of the analysis of the electric forces than in that of molecular gravitation. If this last is, from its complexity, unmanageable except in the simplest cases, it is no wonder that electrical dynamics has not been mathematically studied further than in one dimension, and never at all in surface. Even this much would be hardly effected but for a last fundamental idea, established by M. Ampère; that in an infinitely small extent, and as long as the distance is not sensibly changed, the electric action is identical for two conducting elements issuing at the same extremities, whatever may be otherwise their difference of form. Such a property must introduce valuable analytical simplifications, tending to establish a remarkable analogy between electric, and ordinary dynamic decompositions.

These are the grounds on which the study of the various action of electrized threads proceeds. Among the many dispositions of these conductors, the most interesting case is that of the spiral form; and especially when the turns are very close together. M. Ampère has shown the high importance of this form, in order to imitate, as exactly as possible, the phenomena characteristic of magnetized bodies.*

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Conclusion of Physics.

We have now reviewed the philosophy of Physics, noticing in turn the aspects presented by the study of the properties common to all substances and all structures. These are not so much branches of a single study as distinct sciences. Part of our business has been to carry on a philosophical operation, hardly necessary in astronomy, but becoming more and more so as we descend to the more complex sciences;—that of disengaging real science from the influence of the old metaphysical philosophy, under which it still suffers deplorably, and which manifests itself in Physics through illusory and arbitrary conceptions about the primitive agents of phenomena. I have been able only to indicate the mischief, and where it resides; and I must leave the work of purification to rational philosophers, whose attention will, we must hope, be more and more drawn to this vital question. It is with the same view that I have endeavored to assign the true application of mathematical theories to the principal branches of physics, pointing out by the way the danger of the excessive systemization which is too often sought by carrying the use of this powerful instrument further than the complex nature of the corresponding phenomena would fairly allow. While giving my chief attention throughout to the method, I have pointed out, in brief, the principal natural laws relating to each department of science, discovered by human effort during the two centuries which have elapsed since the birth of Physics, properly so called: and I have shown what gaps are disclosed in the course of such a survey.

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* M. Comte concludes the section on Electricity by a slight reference to the discoveries of Oersted, Arago, and others, regarding its virtual identity with all we term the magnetic forces. But as the whole of this most interesting and important part of Physics has taken a new form since the date of his work, it has not, for reasons assigned in the Preface, been thought necessary to reproduce his remarks in this place.—J. P. N.

Our next study will be of the last science which belongs to the class of general knowledge, or that of inorganic nature. Chemistry relates to the molecular and specific reactions which different substances exert upon each other. It is a more complex, and consequently more imperfect science than those which we have reviewed: but its general character may be perfected, through the means afforded by its subordination to the anterior sciences.

BOOK IV.

CHEMISTRY.

CHAPTER I.

Its nature.

WE have now to review the last of the sciences which relate to the inorganic world. Chemistry has for its object the modifications that all substances may undergo in their composition in virtue of their molecular reactions. Without this new order of phenomena, the most important operations of terrestrial nature would be incomprehensible to us; and there is no other class of phenomena so intimate and so complex. Inert bodies can never appear so nearly like vital ones as when they produce in each other those rapid and profound perturbations which characterize chemical effects. We shall see hereafter that the spirit of all theological and metaphysical philosophy consists in conceiving of all phenomena as analogous to the only one which is known by immediate consciousness—Life: and we can easily understand that the primitive method of philosophizing must have exerted a more powerful and obstinate dominion over chemical phenomena than any other, in the inorganic world.—We must consider, too, that direct and spontaneous observation must have been applied in the first place only to very complicated phenomena, such as vegetable combustions, fermentations, etc., the analysis of which now requires all the resources of our science: and that the most important chemical phenomena are produced only in artificial circumstances, which were long in being devised, and very difficult at first to institute. Easy as it is now for even the most ordinary inquirers to use known substances for the disclosure of new relations, we can hardly imagine the difficulty there must have been, in the infancy of chemistry, in creating suitable subjects for observation: and we can not suppose that the ancient investigators of nature could have had energy and perseverance to discover the principal phenomena of the science if they had not been constantly stimulated by the unbounded hopes arising from their chimerical notions of the constitution of matter.

Great imperfection.

The complex and doubtful nature of the phenomena, in the first place, and next, the difficulty of getting at them, are quite enough to account for the tardy and incomplete positivity of chemical conceptions, in comparison with all others in the inorganic region of nature. If, as we have seen, Physics is defective in several respects, much more must that science be so which, being at once more difficult and more recent, seeks the laws of composition and decomposition. Whichever way we look at it, whether speculatively, as to the value of its explanations, or actively, as to the previsions which they admit of, this science is evidently the least advanced of all the branches of inorganic philosophy. Indeed, it is hardly possible to call chemistry a science at all while it scarcely ever leads to that precise prevision which is the criterion of perfection in speculative knowledge. We can rarely tell what will be the result of the smallest and fewest modifications introduced among the best explored chemical operations; and while that is the case, however important and numerous may be the facts collected, we are in possession of only erudition, and not science. To suppose otherwise is to mistake a quarry for an edifice.

Capacities.

It is not to be hoped that chemistry can ever attain a state of rationality so satisfactory as that of the sciences which relate to phenomena of a more simple character; and especially that of the eternal type of natural philosophy—Astronomy. But so much of its inferiority seems to be due to a vicious philosophy, and to the defective education of philosophers, that I can not but hope that a judicious philosophical analysis may contribute to a speedy perfecting of so important a science. This is the conviction that I desire to awaken by the rapid sketch which I propose to offer of chemical philosophy, regarded in all its essential aspects. Little as can be done within the bounds of this section, it is possible that some one eminent inquirer may be impressed by the necessity of submitting to a new and more rational elaboration the fundamental conceptions which constitute the science.

Object of Chemistry.

First,—what is the general object of Chemistry? Vast and complex as is its subject, the definition of Chemistry is easier than that of Physics. We are already prepared for it, indeed, by having contrasted that of Physics with it. It is easy to characterize the phenomena of chemistry, in a direct and marked manner; for all indicate an alteration, greater or smaller, in the constitution of bodies: that is, a composition or decomposition, and generally both, taking into the account the whole of the substances which participate in the action. Thus, at all epochs of scientific development, since chemistry first became an object of speculative study, chemical researches have steadily manifested a remarkable originality, which has prevented their being confounded with other parts of natural philosophy; even while Physics itself was mixed up, as its title shows, with physiology; which was the case up to a very recent time.—It is by this general character of its phenomena that Chemistry is distinguished from Physics which precedes it, and Physiology which follows it. The three sciences may be considered as having for their object the molecular activity of matter, in all the different modes of which it is susceptible. Each corresponds to one of three successive degrees of activity, which are essentially and naturally distinguished from each other. The chemical action obviously presents something more than the physical action, and something less than the vital. The physical activity modifies the arrangement of particles in bodies; and these modifications are usually slight and transient, and never alter the substance. The chemical activity, on the contrary, besides these alterations in the structure and the state of aggregation, occasions a profound and durable change in the very composition of the particles: the bodies which occurred in the phenomenon are no longer recognizable,—so much has the aggregate of their properties been disturbed.—Again, physiological phenomena show us the molecular activity in a much higher degree of energy; for, as soon as the chemical combination is effected, the bodies become, once more, completely inert; while the vital state is characterized, over and above all physical and chemical effects, by a double continuous motion of composition and decomposition, adapted to maintain, within certain limits of variation and of time, the organization of the body by incessantly renewing its substance. This is the gradation, which no sound philosophy can ever confound, of the three modes of molecular activity.

Two more characteristics of this science must be pointed out: one relating to its nature, and the other to its general conditions.

Specific character of its action.

Chemistry would not be classed among the inorganic sciences unless its phenomena were general; that is, unless every substance were susceptible of chemical action, more or less. And it is because chemistry is thus radically different from physiology that it ranks as the last of the inorganic sciences,—physiological phenomena being, by their nature, peculiar to certain substances, organized in certain modes. Nevertheless, it is incontestable that chemical phenomena present, in every case, something specific, or, to use Bergmann's energetic expression, *elective*. Not only does each material element produce chemical effects which are altogether peculiar to it, but it is the same with their innumerable combinations of different orders, among the most analogous of which certain fundamental differences are observable, even so as to be adopted as their characteristics. While, therefore, physical differences among different bodies are those of degree only, chemical properties are specific. Physical properties afford the common foundation of material existence; and it is by chemical properties that individuality is manifested.

Condition of action

The other characteristic relates to the mode of chemical action. The immediate contact of antagonistic particles is absolutely necessary to chemical action; and therefore one at least of the substances concerned must be fluid or gaseous. When this condition does not already exist, it must be artificially procured by liquefying the substance. It is the earliest axiom in the science, that combination can not take place, except under this condition; and there is not an instance upon record of chemical action between two solids, unless at a temperature which obscures the true state of aggregation of substances; and the action is never so powerful as when both substances are liquid. These facts establish the eminently molecular character of chemical effects, and especially in comparison with physical effects. The distinction from physiological effects is, though less marked, as real, the latter requiring, as we shall see hereafter, the junction of solids with fluids.

Definition.

The definition of Chemistry, then, is that it relates to the laws of the phenomena of composition and decomposition, which result from the molecular and specific mutual action of different substances, natural or artificial.

It will be long, we must fear, before a more precise definition than this can be given. Meantime, however incomplete, the most rational that can as yet be offered is of importance as far as it goes. In this view, and connecting, as usual, the consideration of science with that of prevision, the aim proposed should be this: the characteristic properties of substances, simple or compound, being given, and those properties being placed in a chemical relation in well-defined circumstances, to determine in what their action will consist, and what will be the chief properties of the new products. This problem is, at all events, determinate; and nothing contained in it could be omitted without its ceasing to be so; and the formula, therefore, contains nothing superfluous. On the other hand, if we could obtain such solutions as are indicated, the application of chemistry to the three great objects, vital phenomena, the natural history of the globe, and industrial operations, would be rationally organized, instead of being, as now, the almost accidental result of the spontaneous development of science. Each question would at once be referred to our formula, the data of which would be supplied by the circumstances peculiar to the application. Far distant as we are from being able thus to conduct our inquiries, this is the end to be kept in view: and chemists all agree that the most advanced portions of their science are those few and simple questions in which this aim has been more or less completely attained.

By a continued application of this method, all the data must finally be reducible to the knowledge of the essential properties of simple substances, which would lead to that of the different immediate principles; and, consequently, to the most complex and remote combinations.

Elements.

As for the study of the elements, that must, of course, be a matter of direct, experimental elaboration, divided into as many parts as there are undecomposed substances. Whether or not it may be possible to discover, by rational methods, relations between the chemical properties of each element and its aggregate physical properties, we must lay down as indispensable a direct exploration of the chemical characters of each element. This general basis once obtained from experiment, all other chemical problems must be susceptible of a rational solution, under a small number of invariable laws.

Combination.

The classes of combinations naturally divide themselves into two, according, first, to the simplicity, or the greater or less degree in which the immediate principles are compounded, and, secondly, the number of elements combined. Chemical action is observed to become more difficult the more substances are compounded: the greater part of compound atoms belong to the first two orders; and beyond the third their composition seems almost impossible: and, in the same way, in regard to the number of elements, combinations lose their stability in proportion as the elements are multiplied:—there are usually only two; and scarcely anybody involves more than four. Thus, the number of chemical classes must always be very small in regard to the distinction under notice: and each of them must have a corresponding law of combination, according to which the result might be certainly anticipated through a knowledge of the data. This would be the scientific perfection of chemistry. Our prodigious remoteness from such a state is ascribable to the feebleness of our faculties, and, in an accessory way, to their vicious direction. We must remember that the great aim has begun to be fulfilled in one secondary department of chemical research,—the study of proportions, as we shall see hereafter. What has been done in that one category makes us ask why an analogous perfection should not be attained in other departments. We may sum up this account of the requisites, with the fully rational definition of Chemistry, that it has for its object,—the properties of all simple bodies being given, to find those of all the compound bodies which may be formed from them. Every science falls short of its definition: but a real definition is the first evidence that a science has attained some consistency: it then measures its own advancement from one epoch to another; and it always keeps inquirers in a right direction, and supports them in a philosophic progress.

Rational definition.

Means of investigation.

Looking now at our means of investigation, we shall find that in chemistry the law holds good that the complication of phenomena coincides with the extension of our means of inquiry.

Observation.

Here *Observation* begins to find its full development. Up to this time it has been more or less partial. In astronomy it is confined to the sense of sight: in physics we use hearing and touch also; and chemistry employs, besides these, taste and smell. How much is thus gained we may know by imagining what would become of chemistry, if we were without taste and smell, which are often the only means by which we can recognise effects produced. The important thing to observe under this head is that there is nothing accidental, nor even empirical, in such a correspondence; for, as we shall hereafter see, the sound physiological theory of sensation shows that the apparatus of taste and smell, unlike that of the other senses, operates in a chemical manner, and thus shows these two senses to be specially adapted for the perception of phenomena of composition and decomposition.

Experiment.

As for *Experiment*, it is enough to say that the greater number of chemical phenomena, and especially the most instructive, are of artificial production. Still, we must remember that the essential character of experimentation consists in the institution, or the choice of the circumstances of the phenomena, in order to a more evident and decisive investigation. This process is more difficult in chemistry than in physics, because it is more difficult to institute two parallel cases, undisturbed by the intrusion of irrelevant influences; and yet this is the fundamental condition of experimentation. On this account, I dissent from the ordinary supposition that the experimental method is more appropriate to chemical than to physical researches. Though this is my view, and though the greater advancement of physics gives it the advantage over chemistry in the use of experiment, I can have no doubt of the powerful influence of experimentation in chemistry, independently of its having supplied new subjects of observation. From the early days of the science, the immortal series of Priestley's experiments, and yet more, those of Lavoisier, have offered admirable models, almost comparable to the most perfect researches in physics, and quite enough to prove that there is nothing in the nature of chemical phenomena to prevent the extended and luminous employment of the experimental method.

Comparison.

The third means, *Comparison*, which we have before seen to be inapplicable in Astronomy, and of especial use in Physiology, begins to have a real use in Chemistry. The essential condition of this valuable method is that there shall be an extended series of cases, analogous but distinct, in which a phenomenon shall be modified more and more, whether by successive simplifications or gradations. It is evident that this can take place fully only with regard to vital phenomena; accordingly, it is only by physiological analysis that a clear idea of its value can be obtained. But chemical phenomena approach those of physiology nearly enough, not only to demand this method, but to indicate that without it the science can never find the road to perfection. The existence of natural families in chemistry is now admitted by the best inquirers: but the classification remains to be made. The need of the classification must lead to the use of the comparative method, both being based on the common consideration of the uniformity of certain preponderant phenomena in a long series of different bodies. There is even such a connection between the two orders of ideas that the construction of a natural chemical classification is impossible without a large application of the comparative art, as the physiologists understand it; and conversely, comparative chemistry cannot be regularly cultivated without the guidance of some sketch of a natural classification. Chemistry is at present only a nascent science; general methods are as yet scarcely recognised in connection with it; and only a very few researches afford an example of the comparative method; but I am persuaded, not only of the fundamental suitability of that method in chemistry, but of its application, before very long, to the perfecting of the science. Such an anticipation, somewhat preceding the spontaneous development of any science, may be a contribution to its actual progress.

Chemical analysis and synthesis.

All the means employed are subject, especially, but not solely in chemistry,—to a verification by the precise collation of the two procedures of *analysis and synthesis*;—or, (as these terms have been corrupted by metaphysical uses) composition and decomposition.—Every substance which has been decomposed must evidently be capable of recomposition, whether the process be otherwise practicable or not. If the inverse operation reproduces precisely the primitive substance, the chemical demonstration is complete. Unfortunately, the vast extension of chemical resources in this century has had a much stronger bearing on analytical powers than synthetical means; so that there is at present little proportion and harmony between the two methods.—Such harmony is indispensable to the establishment of certainty in some cases, as we see when we duly distinguish two widely differing kinds of chemical analysis: the preliminary, consisting of the simple separation of the immediate principles; and the final, leading to the determination of the *elements*, properly so called. Though both are essential to chemical research, the first is of the most important and extensive use. The elementary analysis might be spared a synthetical verification,—because the composition of the reacting substances may be compared with the results obtained, thus indicating the composition of the proposed substance, the different elements of which will in this way have been in some sort separated. The impossibility of recombining the elements, to reproduce the primitive body, ought not to throw any doubt on the solution, unless there is some special reason for suspecting the simplicity of any one of the elements. Synthesis can, in this case, only add a valuable confirmation, to what was before not doubtful. But the case is very different when we have to determine only the immediate principles. As the elements concerned can produce combinations of different orders, we can never be sure that one or more of the supposed immediate principles obtained does not result from the reactions caused by the analysis itself. It is only synthesis which, by reconstructing the proposed substance with the materials concerned, can decide the question conclusively, though in some cases of feeble agency in the reactives, and strong analogical induction, there is no room left for reasonable doubt. In immediate analyses of great complexity, when the agreement of various analytical means strongly corroborates the conclusions obtained, we can not rely on real chemical demonstration without the synthetical confirmation. This maxim of chemical philosophy is abundantly exemplified in the analysis of mineral waters, and yet more of organic substances.—It is noticeable that synthesis is easiest where it is most necessary, and would be most difficult in the case of elementary analysis, where it can, as we have seen, be dispensed with. This is owing to the combinations becoming less tenacious as the order of composition of the constituent particles is higher; and if the decomposition is easy, so is the recomposition. The cases of immediate analysis require only feeble antagonisms, offering no great obstacles to the synthetical operations indispensable for their demonstration.

Rank of the science.

We have next to consider the encyclopedical position of Chemistry, to justify the rank assigned to it in our scale.

It is from no vain and arbitrary consideration that Chemistry is placed between Physics and Physiology in our scale. By the important series of electro-chemical phenomena Chemistry becomes, as it were, a prolongation of Physics: and at its other extremity, it lays the foundations of physiology by its research into organic combinations. These relations are so real that it has sometimes happened that chemists, untrained in the philosophy of science, have been uncertain whether a particular subject lay within their department, or ought to be referred either to physics or to physiology.

The phenomena of Chemistry are more complex than those of Physics, and are certainly dependent on them. Their degree of generality is inferior,—chemical effects requiring a much more extended concurrence of varied conditions. Physical properties belong not only to all substances, but, with simple modifications, to all the states of aggregation, and even of combination, of each of them: whereas, it is only in a more or less determined and restricted condition that each body manifests its chemical properties. In a word, nature often shows us physical effects apart from the chemical, while there can be no chemical effects apart from certain physical phenomena. Thus Chemistry can not be rationally studied without a previous knowledge of physics. Besides, the most powerful chemical agents are derived from physics, which presents, in its different orders of phenomena, the first distinctive characters of different substances. It is impossible in our day to conceive of scientific chemistry without giving it the whole of physics for its basis: and thus is its first relation in the scale established. And, as physics is dependent on astronomy and mathematics, so must its own dependent be. But it must be owned that, with regard to doctrine, the connection of Chemistry with the first two sciences is neither extensive nor very important.

Every attempt to refer chemical questions to mathematical doctrines must be considered, now and always, profoundly irrational, as being contrary to the nature of the phenomena. In the case of physics, the mischief would be, as we have seen, merely from the misuse of an instrument which, properly directed, may be of admirable efficacy: but if the employment of

Relation to Mathematics.

mathematical analysis should ever become so preponderant in chemistry (an aberration which is happily almost impossible) it would occasion vast and rapid retrogradation, by substituting vague conceptions for positive ideas, and an easy algebraic verbiage for a laborious investigation of facts. The direct subordination of chemistry to astronomy is also slight, but more marked. It is almost insensible in regard to abstract chemistry, which alone is cultivated in our day. But, when the time shall come for the development of concrete chemistry,—that is, the methodical application of chemical knowledge to the natural history of the globe,—astronomical considerations will no doubt enter in where now there seems no point of contact between the two sciences. Geology, immature as it is, hints to us such a future necessity, some vague instinct of which was probably in the minds of philosophers in the theological age, when they were fancifully and yet obstinately bent on uniting astrology and alchemy. It is, in fact, impossible to conceive of the great intestinal operations of the globe as radically independent of its planetary conditions.—Inconsiderable as are the relations of chemistry with mathematics and astronomy, in regard to doctrine, it is far otherwise with regard to method. It is easy to see how the perfection of chemistry might be secured and hastened by the training of the minds of chemists in the mathematical spirit and astronomical philosophy. Besides that mathematical study is the necessary foundation of all positive science, it has a special use in chemistry in disciplining the mind to a wise severity in the conduct of analysis: and daily observation shows the evil effects of its absence. Yet, it can never be said that chemists have so much need of a mathematical education as physicists, because they do not need it as an instrument in daily use, but as an intellectual preparation for the rational study of nature. As to astronomy, we have seen that it constitutes the most perfect type of the study of nature; and this at once establishes its relation of superiority to chemistry. The more complex the phenomena, the more important is the influence of such a model; and it is only by having always before their eyes such an exemplification of the true spirit of natural philosophy, that chemists can rightly estimate the inanity of the metaphysical explanations which vitiate their doctrine, and can acquire an adequate sense of the true character, conditions, and destiny of chemical science. Under this point of view, astronomy is more useful to chemists than even physics, in proportion to the superiority of its method.

To Astronomy.

So much for the sciences which precede chemistry. As for those that follow, physiology depends upon chemistry both as a point of departure and as a principal means of investigation. If we separate the phenomena of life, properly so called, from those of animality, it is clear that the first, in the double intestinal movement which characterizes them, are essentially chemical. The processes which result from organization have peculiar characteristics; but apart from such modifications, they

To Physiology.

To Sociology.

are necessarily subjected to the general laws of chemical effects. Even in studying living bodies under a simply statical point of view, chemistry is of indispensable use in enabling us to distinguish with precision the different anatomical elements of any organism.—We shall see hereafter that the new science of Social Physics is subordinated to chemical science. In the first place, it depends on it by its immediate and manifest connection with physiology: but, besides that, as social phenomena are the most complex and particular of all, their laws must be subject to those of all the preceding orders, each of which manifests, in social science, its own peculiar influence. In regard to Chemistry especially, it is evident that among the conditions of man's social existence several chemical harmonies between man and external circumstances are involved. Even if individual existence could be sustained, society could not, if these harmonies were destroyed, or even only somewhat disturbed,—as by changes in the atmospheric medium, or in the waters or the soil.

Degree of possible perfection.

The position of Chemistry among the sciences being thus determined, the next inquiry is about the degree of scientific perfection that its nature admits, in comparison with others. As for the method, if physics suffers from the intrusion of hypotheses, we may say that chemistry has been their absolute prey, through its more difficult and tardy development. The doctrine of *affinities* appears to me more ontological than that of fluids and imaginary ethers. If the electric fluid and the luminous ether are, as I called them before, materialized entities, *affinities* are at bottom pure entities, as vague and indeterminate as those of the scholastic philosophy of the Middle Age. The pretended solutions that they yield are of the usual character of metaphysical explanations,—a mere reproduction, in abstract terms, of the statement of the phenomenon. The advance of chemical knowledge which must at last discredit for ever such vain philosophy has as yet only modified it, so far as to disclose its radical futility. While affinities were regarded as absolute and invariable, there was at least something imposing in them; but since facts have compelled the belief of their being variable according to a multitude of circumstances, their use has only tended to prove, more and more, their utter inanity. Thus, for instance, it is known that at a certain temperature, iron decomposes water, or protoxide of hydrogen: and yet, it has been since discovered that, under the influence of a higher temperature, hydrogen in its turn decomposes oxide of iron. What signifies, in this case, any order of affinity that we may ascribe to iron and hydrogen with oxygen? If we make the order vary with the temperature, we have a merely verbal, and therefore pretended explanation. Chemistry affords us now many such cases, apparently contradictory, independently of the long series of decisive considerations that have made us reject absolute affinities,—the only ones, after all, that have any scientific consistency whatever. The old habit is, however, so strong that

Intrusion of hypotheses.

even Berthollet, in the very work in which he overthrows the old doctrine of invariable or elective affinities, proposes vague affinities under many modifications. The strange doctrine of predisposing affinity is to be found in the work, among others, of the most rational of recent chemists, the illustrious Berzelius. When for instance, water is decomposed by iron through the action of sulphuric acid, so as to disengage the hydrogen, this remarkable phenemenon is commonly attributed to the affinity of the sulphuric acid for the oxyde of iron which *tends* to become formed. Now, can anything be imagined more metaphysical, or more radically incomprehensible, than the sympathetic action of one substance upon another which does not yet exist, and the formation of the last by virtue of this mysterious affection? The strange fluids of physicists are rational and satisfactory in comparison with such notions. These considerations justify the desire that chemists should have a sufficient training in mathematical, astronomical, and then in physical philosophy, which have already put an end to such chimerical researches within their own domain, and would discard them speedily from the more complex part of natural philosophy. It is only by having witnessed the purification in the anterior sciences that chemists could realize it in their own: and there could not be complete positivity in chemistry if metaphysics lingered in astronomy or physics. This, again, justifies the place assigned to chemistry among the sciences. The individual must follow the general course of his race in his passage to the positive state. He must find that true science consists, everywhere, in exact relations, established among observed facts, allowing the deduction of the most extensive series of secondary phenomena from the smallest possible number of original phenomena, putting aside all vain inquiry into causes and essences. And this is the spirit which has to be made preponderant in chemistry,—dissolving for ever the metaphysical doctrine of affinities.

Actual imperfection.

The inferiority of chemistry to physics, in regard to method and doctrine, explains its relative imperfection with regard to actual science. We have only to compare with the formula which told us what chemistry ought to be what it actually is, to see that it is at an immense distance—much further than physics—from its true scientific aim. Chemical facts are at this day essentially incoherent, or, at best, feebly co-ordinated by a small number of partial and insufficient relations, instead of those certain, extended, and uniform laws of which physics is so justly proud. As for prevision, if it is imperfect in physics in comparison with astronomy, it can hardly be said to exist in chemistry at all; the issue of each chemical event being usually known only by specially consulting the immediate experiment, when, as it were, the event is already accomplished.

Comparative imperfection.

Imperfect as chemistry is, in regard to method and doctrine, it is yet superior to physiology, and still more to social science, not only because, from the comparative simplicity of its phenomena, the facts and investigations are clearer and more decisive, but because it has a few, though very few, real theories, capable of affording complete previsions; a thing as yet impracticable, except in a general manner, with living bodies. We shall have occasion to notice the theory of proportions, the equivalent of which is not, in any sense, to be looked for in physiology. We must remember, while estimating the comparative imperfection of the sciences, that the importance to us of their perfection is in proportion to their simplicity; our available means being always found to correspond with our reasonable wants. I hope, too, that this severe estimate of the actual state of each science will stimulate rather than discourage the student; for it is more gratifying to our human activity to conceive of the sciences as susceptible of vast. varied, and indefinite progress, than to suppose them perfect, and therefore stationary, except in their secondary developments.

This leads us to consider the function of Chemistry in the education of the human mind.

Relation to human progress.

It may be said to train us in the great art of experimentation; not as being our exclusive teacher, for, as we have seen, physics is superior to it in this; and it is more the art of observing than of experimenting that Chemistry is chiefly distinguished for. But there is an important part of the positive method which chemistry seems destined to carry to the highest perfection. I do not mean the theory of classifications, of which chemists know too little at present; but the art of rational nomenclatures, which is quite unconnected with classifications. Since the reform in chemical language, attempts have been incessantly made, to this hour, to form a systematic nomenclature in anatomy, in pathology, and especially in zoology; but these endeavors have not had, and never can have, any success to compare with that of the reformers of chemical language; for the nature of the phenomena does not admit of it. It is not by accident that the chemical nomenclature is alone in its perfection. The more complex phenomena are, and the more varied and less restricted the comparisons of objects, the more difficult it becomes to subject them to a system of denominations, at once rational and abridged, so as to facilitate the habitual combination of ideas. If the organs and tissues of the living body differed only from one point of view; if maladies were sufficiently defined by their seat; if, in zoology, genera, or at least families, could be established by a homogeneous consideration, the corresponding sciences might at once admit of systematic nomenclatures as rational and as efficacious as that of Chemistry. But the diversity of aspects, rarely reducible to one head, renders such an arrangement extremely difficult and not very advantageous.

Art of nomenclature.

The case of chemistry is the only one in which, by its nature, the phenomena are simple, uniform, and determinate enough to allow of a rational nomenclature at once clear, rapid, and complete, so as to contribute to the general progress of the science. The idea of composition, the great end of the science, is always preponderant. Thus, the systematic name of each body, expressing its composition, indicates first a correct general view, and then, the sum of its chemical history; and, by the nature of the science, the more it advances toward perfection, the more must this double property of the nomenclature be developed. In another view, dualism being the commonest constitution in chemistry, and the most essential, and that to which all other modes of composition are more and more referred by science, we see that the conditions of the problem are as favorable as possible to a rapid and expressive nomenclature. Thus, there has always been some system of nomenclature, more or less rough, though none to be compared to that so happily founded by Guyton-Morveau. Though the art can manifest its excellence only in proportion to the advance of chemistry, it is in such harmony with the nature of the science that, in its present imperfect state, it upholds it, by provisionally supplying, as it were, the almost absolute deficiency of true rationality. Thus chemistry may be regarded as specially adapted to develop one of the few fundamental means, the aggregate of which constitutes the general power of the human mind. The formation of a similar aid in the more complex sciences offers a real and strong interest; and I have only desired to show that we must resort to chemistry for the true principles and general spirit of the art of nomenclature, according to the rules so often set forth in this work, that each great logical artifice should be directly studied in the department of natural philosophy where it is found in the greatest perfection, that it may be afterward applied in aid of the sciences to which it less specially belongs.

State of chemical doctrine.

The high philosophical properties of Chemistry are more striking in regard to doctrine than to method. However imperfect our chemical science is, its development has operated largely in the emancipation of the human mind. Its opposition to all theological philosophy is marked by the two general facts in which it has a share with all the rest of positive philosophy—first, the prevision of phenomena, and next, our voluntary modification of them. We have already seen that the more the complexity of phenomena baffles our prevision, the greater becomes our power of modifying them, through the variety of resources afforded by the complexity itself; so that the anti-theological influence of science is infallible, in the one way or the other. In chemistry, our modifying power is so strong that the greater part of chemical phenomena owe their existence to human intervention, by which alone circumstances could be suitably arranged for their production; and if the phenomena of physiology and social science admit of modification in a yet greater degree, chemistry will always, in this particular, hold the first rank, since the highest order of modifications is that which we here find—those which are most important for the amelioration of the condition of man. In the system of the action of man upon nature, chemistry must ever be regarded as the chief source of power, though all the fundamental sciences participate in it more or less.

In this way, chemistry effectually discredits the notion of the rule of a providential will among its phenomena. But there is another way in which it acts no less strongly; by abolishing the idea of destruction and creation in nature. Before anything was known of gaseous materials and products, many striking appearances must inevitably have inspired the idea of the real annihilation or production of matter in the general system of nature. These ideas could not yield to the true conception of decomposition and composition till we had decomposed air and water, and then analyzed vegetable and animal substances, and then finished with the analysis of alkalies and earths, thus exhibiting the fundamental principle of the indefinite perpetuity of matter. In vital phenomena, the chemical examination of not only the substances of living bodies, but their functions—imperfect as it yet is—must cast a strong light upon the economy of vital nature by showing that no organic matter radically heterogeneous to inorganic matter can exist, and that vital transformations are subject, like all others, to the universal laws of chemical phenomena. Chemical analysis seems to have fulfilled its function in this direction: henceforth it must be by the more difficult, but more luminous method of synthesis that this great philosophical revolution must be completed: and attempts enough have been successfully made to prove the possibility of it.

Divisions of the science.

The divisions of the science have not been clearly and permanently settled, partly because of its very recent origin, and partly on account of its nature. In the first place, students have been more occupied in multiplying observations than in classifying them; and in the next, the homogeneous character of chemical phenomena causes essential differences to be less profound, and therefore less marked, than in any other of the fundamental sciences. In astronomy, there can be no question of a division into geometrical and mechanical phenomena. Physics is less a unique science than a group of almost isolated sciences; and they indicate their own arrangement. We shall see hereafter that nearly the same thing happens, though from a different cause, in physiology. But in chemistry, the conditions are less favorable, the distinctions being scarcely more marked than those which exist in a single department of physics—as thermology, and yet more, electrology. The imperfection and small importance of its present divisions are easily explained: and there are strong symptoms of an approaching discussion of this great subject; for the majority of eminent chemists are more or less dissatisfied with the provisional division which they have been hitherto obliged to accept as guidance in their labors.

No organic chemistry.

The general division of *organic* and *inorganic* chemistry can not be sustained, on account of its evident irrationality. What is at present called organic chemistry has an essentially bastard character, half chemical, half physiological, and not, in fact, either the one or the other, as we shall have occasion to see. The division can not even be sustained under another form, as equivalent to the general distinction between cases of dualism and of other composition. For if inorganic combinations are usually binary, there are some which are composed of three elements and even of four; while, conversely, we very often meet with a true dualism in bodies which are called organic. For a genuine division we must look to general ideas relating to composition and decomposition; and in this form, attending to the rule of following the gradual complication of phenomena: first, the growing plurality of constituent principles (mediate or immediate), according as the combinations are binary, ternary, etc.; and secondly, the higher or lower degree of composition of the immediate principles, each of which may (as in the case of a continual dualism) be decomposable into two others, for a greater or smaller number of consecutive times. Though each of these two points of view is of high importance, the preponderance of the one or the other must be agreed upon before the rational division of chemistry can be organized. Though this is not the place to discuss this new question of high chemical philosophy, it may be well to state that I regard it as solved; and that the consideration of the degree of composition is, in my eyes, evidently superior to that of the number of elements, inasmuch as it affects more profoundly the aim and spirit of chemical science, as they have been characterized in this chapter. As for the rest, whatever the decision may be, we may remark that the two classifications differ from each other much less than we might at first be tempted to suppose; for they necessarily concur, whether in the preliminary or in the final case, and diverge only in the intermediate parts.

Principles of composition and decomposition

We have now reviewed the nature and spirit of chemical science; the means of investigation proper to it; its true encyclopedical position; the kind and degree of perfection of which it is susceptible; its philosophical properties in regard to method and to doctrine; and, finally, the mode of division which would be suitable to it. We must complete the survey of the science by a special and direct notice of the few essential doctrines which have been disclosed by the spontaneous development of chemical philosophy. It must be remembered that the object of this work is not to present a treatise on each science, or to enlarge upon it in proportion to its proper importance, or the multiplicity of its facts; but to ascertain its relative importance, as one head of positive philosophy. No one will expect that chemical philosophy, in its present state, can be examined here as fully or satisfactorily as, for instance, astronomical philosophy, the perfection of which admits of a methodical analysis, clear and complete, though summary, such as befits that immutable type of natural philosophy.

CHAPTER II.

INORGANIC CHEMISTRY.

Mode of beginning the study.

WHATEVER may be the principles of division and classification preferred in the general system of chemical studies, it is agreed by almost all chemists that the preliminary and fundamental study should be the successive and continuous history of all the simple bodies. The plan of M. Chevreul is an exception to this, his method being to proceed at once from the study of each element to all the combinations, binary, ternary, etc., that it can form with those already examined; confining himself, however, to compounds of the first order. This plan has the advantage that simple bodies are more completely known from the beginning than by the usual method, which scatters through the different parts of the science the most important chemical properties of each of them. But, on the other hand, the history of any element remains incomplete; a factitious inequality is established among chemical researches into different elementary substances; and the didactic inconvenience which M. Chevreul proposed to escape seems to be unavoidable, under any method. On no plan can any chemical history be completed by a first study. The provisional information obtained by a first study must be followed by a revision which allows us to take into consideration the whole series of phenomena relative to each substance. The question is merely a didactic one, only of secondary importance in this work, though of great practical interest. On any scheme, it remains certain that the preliminary study of elementary substances is, by the nature of the science, the necessary foundation of chemical knowledge.

Plurality of elements.

On account of the considerable and always increasing number of substances regarded as simple, some modern philosophers, possessed with the notion of the simplicity and economy of nature, have concluded *à priori* that most substances must be the various compounds of a much smaller number of others. But, while endeavoring to conceive of nature under the simplest aspect possible, we must do so under the teaching of her own phenomena, not substituting for that instruction any thoughtless desires of our own. We have no right to presume beforehand that the number of simple substances must be either very small or very large. Chemical research alone should settle this; and all that we are entitled to say is that our minds are disposed to prefer the smaller number, even, if it were possible, so far as there being but two. But not the less are we bound to suppose all substances which have never in any way been decomposed to be simple, though we should not pronounce them to be for ever undecomposable. All chemists now admit this rule as the first axiom of sound chemical philosophy.

Aristotle first saw this rule, though he did not conceive of its rational grounds. His doctrine of the four elements, popularly cried down in our time, should be judged of as the first attempt of the true philosophical spirit to conceive of the composition of natural bodies, amid the then existing deficiency of all suitable means of research. To appreciate it we must compare it with anterior notions. Now, up to that time, all the schools, however they might differ about other things, agreed that there was only one elementary substance; and their dispute was about the choice of the principle. Aristotle, with his rational character of mind, put an end to all those barren controversies by establishing the plurality of elements. This immense progress must be considered the true origin of chemical science, which would be radically impossible on the supposition of a single element, excluding all idea of composition and decomposition. Whatever appearances may be, there is no doubt that it must be much more difficult for the human mind to pass from the absolute idea of unity of principle to the relative idea of plurality, than to rise gradually, by means of research, from the four elements of Aristotle to the fifty-six simple bodies of our chemistry of this day. Our *Naturists*, who are all for simplicity and economy without caring much for reality, have no right to appeal to the authority of Aristotle, who had so much reverence for reality as to infringe the notion of simplicity which he found prevailing. They should go back further than Aristotle,—to Empedocles or Heraclitus,—and attain the utmost simplicity at once, by admitting only a single principle.

Other philosophers, among whom was Cuvier, have objected to the simplicity of most of the elements now admitted by chemists, that some of them seem to be extremely abundant in nature, while others are scantily and partially distributed: whereas, it seems natural to presume that the different elements must be almost equally diffused throughout the globe, and that therefore chemical analysis will, sooner or later, prove the rare ones to be compound substances, requiring peculiar and rare influences for their formation. It would be enough to say that the presumption, though plausible, is nothing more than a presumption: but it may be added that we know nothing of our planet beyond the upper strata; and we can form no prejudgment of the composition of the whole. It would be too much to say that there should be an equality of elements on the surface, even the probability being the other way; for the heaviest elements are the rarest at the surface, and the commonest are those which go to the composition of living bodies; and the probability is strong that the preponderance is reversed in the interior of the globe, to make up the mean density, which is not to be found among the solids, liquids, and gases, which are required for the existence of life. Thus the objection seems to be converted by a chemical analysis into a sort of confirmation.

Since the time—recent, it is true—of the decomposition of the elements of Aristotle, there has not been a single instance of a substance having passed from the class of simple to that of compound bodies, while the inverse case has been frequent. Yet, no chemist disputes the possibility of a reduction of the elements by a more thorough analysis; for chemical simplicity, as it is to us, is a purely negative quality, not admitting of those irreversible demonstrations proper to positive compositions and recompositions. The great general example of substances, called organic, the chemical theory of which is so complex, notwithstanding the small number of their elements, might lead us to suppose that such a reduction would not be, after all, so very great an advantage: but in this case, the difficulty seems to me to be referrible to the deficiency of duality. Notwithstanding this example, we can not but think that chemistry would become more rational and more systematic, if the elements were fewer, from the closer and more general relation which must then subsist among the different classes of phenomena. But the apparent perfection could be only barren and illusory if we were to assume it by conjecture anticipating the real progress of chemical analysis.

Classification of elements.

This profusion of elements has naturally led to endeavors to classify them. The high importance of the question has become manifest through the deep persuasion that the rational classification of simple bodies must determine that of compound substances, and therefore that of the whole chemical system. The first principle to be laid down is that the hierarchy of elementary substances is not to be determined only by their proper essential characters, but by the less direct consideration of the principal phenomena of the compounds which they form. Without this requisition, the classification would have little use or interest; for it would be of small consequence in what conventional order we studied fifty-six bodies all independent of each other: whereas, with its proper condition, this question is as important as any that chemical philosophy can present.

The old division of the elements into the comburent and combustible (those which burn in the active and in the neuter sense), and the subdivision of these into metallics and non-metallics, are evidently too artificial to be maintained, except provisionally. For many years, endeavors have been made to supersede it; but no irreversible classification has been yet obtained. M. Ampère seems to have been the first who pointed out the necessity; and he proposed a system in 1816; but it was not one which induced the chemists to abandon their ancient distribution, the binary structure of which made it easy of application, whatever might otherwise be its defects. A few years after, Berzelius offered, in a simple and almost incidental form and manner, a far superior system of classification. He first understood the necessity of rising finally to a unique series, constituting, by a uniform and preponderant character, a true hierarchy; whereas, M. Ampère saw only the importance of natural groups, which might be arbitrarily co-ordinated. Both conditions are imposed by the general theory of classifications; but that which Berzelius had chiefly in view is unquestionably superior to the other; and especially in the present case, when the small number of objects to be classified renders the formation of groups a matter of secondary importance, provided the series be naturally ordained.

Classification of Berzelius.

M. Berzelius's conception is grounded on the consideration of electro-chemical phenomena. Its simple and lucid principle is that the new elements are to be so disposed as that each shall be electro-negative to those which precede it, and electro-positive to those which follow it. The series thus derived appears, thus far, to be in conformity with the whole of the known properties of both the elements themselves and their principal compounds. It is too soon, however, to speak decisively of this: and, on the other hand, the chemical preponderance of electric characters is by no means so logically established as to compel us to seek the bases of a natural classification in that order of phenomena. It must, it seems to me, be clearly proved at the outset that the point of departure is a real one,—that is, that a constant order of electrization exists among the different elements, which is maintained under all conditions of exterior circumstances, of aggregation and decomposition: but, not only has this never been adequately undertaken, but there is some reason to apprehend that its result would be opposite to the proposed principle. Whatever may be the issue of future labors, Berzelius has secured the eternal honor of having first exhibited the true nature of the problem, and the aggregate of its principal conditions, and perhaps the order of ideas in which its solution is to be sought. Wherever this solution is obtained, chemistry will have made a great stride toward a truly rational state: for, under a hierarchy of the elements, the systematic nomenclature of compound substances will almost suffice to give a first indication of the general issue proper to each chemical event: or, at least, to restrict the uncertainty within narrow limits. Yet, through this very connection of such a research with the whole of chemical studies, I do not think it can be efficaciously pursued while we separate it, as has hitherto been done, from the general question about the establishment of a complete system of chemical classification for all bodies, simple and compound. Now, this great question seems to me at present premature. The preliminary conditions, both of method and of doctrine, are, as we have seen, far from being completed. As such a general system of classification must constitute both the summing up and the fundamental view of the whole of chemical philosophy, I shall further expand my idea about it in this place.

Premature effort.

Requisite preparation as to method.

As for the method, it requires perfecting in two ways, for which chemists must resort to physiology.

They must understand the fundamental theory of natural classifications, which can be obtained nowhere else: and they must, for the same reason, study in the same school the general spirit of the comparative method, of which chemists have very little idea, and without which they can never proceed properly in search of a rational classification. These two improvements must be derived from biological philosophy; the one to lay down the problem of chemical classification, and the other to undertake its solution. It will be by perceiving these harmonies and mutual applications among the sciences commonly treated as isolated and independent, that philosophers in all departments will at length become aware of the reality and utility of the fundamental conception of this work; the cultivation of the different branches of natural philosophy under the impulsion and direction of a general system of positive philosophy, as a common basis and uniform connection of all scientific labors. We have little idea what we lose by the narrow and irrational spirit in which the different sciences are cultivated, and especially with regard to method. When the great scientific relations of the future shall be regularly organized, men will scarcely be able to imagine, otherwise than historically, that the study of nature could ever have been conceived and directed in any other way.

As to doctrine.

As to doctrine, we have seen that the desired classification can not take place till we have settled the preponderance of the one or the other consideration—the order of composition of the immediate principles, or their degree of plurality. Now, such a problem has not yet been rationally proposed. If we suppose it resolved, adopting the rule which I think almost incontestable, as I explained before, of treating the first point of view as necessarily superior to the second, we must still attend to two special conditions, before we can proceed to the rational construction of the system of chemical substances.

First condition.

By the first of these conditions, we must dismiss the irrational distinction of substances into organic and inorganic. We shall see hereafter that organic chemistry must soon dissolve, parting with some of its questions to chemistry proper, and others to physiology. When any combination is susceptible of a chemical examination, it must be subjected to a fixed order of homogeneous considerations, whatever may have been its origin and mode of concrete existence, with which chemistry has nothing to do, unless as a source of information. As long as any classification must be adapted to the strange conception of a sort of double chemistry, established upon a false division of substances, it must be precarious and artificial in its details, because it is vitiated in principle. The evil is felt, as is shown more and more by the tendency to refer organic combinations to the general laws of inorganic combinations; but it would not be enough, as might be supposed, that a distinguished chemist should take the initiative, in a large and direct manner, to accomplish this important reform.

Such a work demands a special and difficult operation, requiring a delicate combination of the chemical and physiological point of view, in order to make a true division of what should remain with chemistry, and what should return to physiology.

Second condition.

The second condition is closely connected with the first. It requires that all combinations should, if possible, be submitted to the law of dualism, erected into a constant and necessary principle of chemical philosophy. Great as would be such an improvement in the way of simplification of chemical conceptions, it must, however, be admitted that it is not so indispensable to classification as the preceding. Without the first condition, rational classification would be impossible; whereas, it might take place, with imperfection and difficulty, without the second. As for the prospects of the case, the tendency to improvement is as real and marked in the one case as the other; as any one may observe for himself.

Method of analysis.

Chemical dualism.

It is of the more importance to set the consideration of the order of composition of immediate principles above that of their degree of plurality, as before proposed, because the first is, by its nature, clear and incontestable, while the other is always more or less obscure and dubious. The one is, in fact, the simple appreciation of an analytical or synthetical fact; the second has always a certain hypothetical character, since we then pronounce upon the mode of agglomeration of elementary particles; which is a thing radically inaccessible to us. Thus, for example, a chemist may establish with certainty that such or such a salt is a compound of the second order, and that certain acids and alkalies are, on the contrary, of the first order; for analysis and synthesis can demonstrate that each of the last bodies is composed of two elementary substances, and that, on the contrary, the immediate principles of the salt are decomposable into two elements. But, in another view, when the analysis of any substance has established the existence in it of three or four elements, as in the case of vegetable or animal matters, we can not without resort to hypothesis, pronounce that this combination is really ternary or quaternary, instead of being simply binary; for we can never assert that we could not, by a preliminary analysis less violent than this final one, resolve the proposed substance into two immediate principles of the first order, each of which should be further susceptible of a new binary decomposition.

If an unskilled chemist should at this day apply unduly strong means to the analysis of saltpetre, the results might authorize him, following our present erroneous procedure, to conceive of this substance as a ternary combination of oxygen, azote, and potassium: and yet we know that such a conclusion would be false, as the substance may be easily reconstructed by a direct combination between nitric acid and potash, which might have been separated by a less disturbing analysis, without occasioning their decomposition. How do we know that it may not be so with every combination habitually classed as ternary or quaternary? Immediate analysis being as yet so imperfect in comparison with elementary analysis, especially with regard to these substances, would it be rational to proclaim, for the time to come, its necessary and eternal impotence with regard to them? Such judgments seem to be founded on a confusion between these two kinds of analysis, so really different in themselves, and so characterized in their operations by delicacy in the one case and energy in the other. One important consideration, relating to the synthetical point of view, is evidence of this confusion between the two analyses; and that is, the extreme difficulty, if not impossibility, of verifying by synthesis the analytical results proper to these substances. We have seen that immediate synthesis is usually very easy, while elementary synthesis is scarcely practicable. Thus, reciprocally, it seems to me rational to suppose that when the recomposition can not be effected, the analysis has not been immediate—there being no other objection to such a conclusion. For example, we exhibit the impossibility of reproducing by synthesis vegetable and animal substances; and this has been even set up as a sort of empirical principle. But is not this impossibility owing to our persisting in an elementary synthesis when we ought to proceed by an immediate synthesis, the materials of which might in many cases be discovered beforehand? This remark is true with regard to a multitude of combinations the dualism of which is, however, very certain, with the sole difference that the immediate principles are better known. If we tried to recompose saltpetre by directly combining oxygen, azote, and potassium, we should succeed no better than in reproducing organic substances by throwing together their three or four elements; the obstacles which we admit in the last case apply equally to the first. The most striking achievement is that of M. Wœhler, in producing the animal substance urea. He could not have done this if he had tried, according to the common prejudice, to combine directly oxygen, hydrogen, carbon, and azote, which concur in the elementary constitution of this substance, instead of uniting only its two immediate principles, till then unknown in this quality. Is there any reason to suppose that it is otherwise in any other case? It appears, then, that chemists will be safe in attributing an entire generality to the fundamental principle of dualism of all combinations, under the one easy condition of regarding as still very imperfect the analysis of substances exceeding the binary composition; and especially the substances called organic, the true immediate principles of which would thus remain to be discovered. These principles can be conceived of only by imagining a considerable number of new binary combinations, of the first and second orders, between oxygen, hydrogen, carbon, and azote; and the realization of this may seem, in the present state of our knowledge, almost impossible. But we have no right to conclude it to be so, while our analytical procedures are what they are; and there is no scientific objection to our supposing that there may be many more direct and binary combinations among the elements of ternary or quaternary substances than chemistry has yet established.

It must be observed, however, that universal and indefinite dualism can not be maintained unless chemists will scientifically determine the sense of the word *substance;* that is, restrict it to mean real *combination:* for it would be easy to cite, and especially in physiological chemistry, very marked cases of the defect of dualism. But we can not regard as a true chemical substance an accidental assemblage of heterogeneous substances, whose agglomeration is evidently mechanical, such as sap, blood, a biliary calculus, etc., unless we confound the notion of dissolution, and even of mixture, with that of combination. If we extend in this way the use of the term *substance*, so valuable in chemistry, we might as well treat, as so many chemical substances, the waters of different seas, different mineral waters, soils, etc.: and even more, artificial mixtures of a variety of salts dissolved together in water or alcohol. We shall see hereafter that all difficulties in this subject may be disposed of by our learning that they proceed from our not having clearly and rigorously separated the chemical from the physiological point of view. We may be assured that the most elementary notions of chemical philosophy can not be rationally established, in their due clearness, generality, and stability, without being founded on a full comparison with biology; a comparison which can be organized only under a complete system of positive philosophy.

Meantime, there is a marked tendency in the present movement of chemical ideas, toward a complete dualism. The increasing assimilation attempted between organic and inorganic substances is an indirect advance in that road: but much more striking, in this view, are experiments like those of Mr. Wœhler, which refer the most refractory compounds to dualism, either by analysis or synthesis. A binary formula is adopted, too, to represent, the proportion of elements proper to the most complete substances: and, though this is not a true dualism, it helps to prepare minds for the establishment of a real and general one. The sum of what has been said on this important subject of chemical dualism is this:—the real mode of agglomeration of elementary particles is, and ever must be, unknown to us, and therefore no proper object of our study:—our positive researches being thus circumscribed, we may rationally conceive of the *immediate* composition of any substance as binary; but so as to represent all the phenomena that chemistry can offer to us, in any future state of perfection. Thus, I do not propose universal dualism as a law of nature; for this we could never establish: but I declare it to be a fundamental artifice of true chemical philosophy, destined to simplify our elementary conceptions, by using our optional intellectual liberty in accordance with the true end and aim of positive chemistry.

These are the conditions necessary to the institution of a system of natural classification, answering in chemistry to the universal hierarchy of living bodies in biology, if the complication of phenomena would admit of our obtaining such a system. Up to this time, perhaps no one has formed an adequate idea of the nature and spirit of such an operation: but in my view, chemical classification, thus conceived of, is the science itself, condensed into the most substantial summary. All I claim to have done is to have introduced into chemical science the special kind of philosophical spirit which is naturally developed by biological science, as it has been conceived of by all its great masters, from Aristotle downward.

It is because I have high expectations of what Chemistry will become, that I attach so much importance to the preceding discussion. The science is now weak and desultory, notwithstanding its rich collection of facts: but, extended and complex as it is, there is no fundamental science, except astronomy, whose phenomena are so homogeneous, and therefore so fit for a true systemization, in the positive spirit. Now, this future constitution of chemical science must, it seems to me, consist in a complete system of natural classification, which can not be obtained till all combinations, whatever their origin, are subjected to a fixed order of homogeneous consideration, and, on the other hand, constantly referred to a fundamental dualism.

We cannot form any certain expectation of the future condition of Chemistry from its present state: but, before proceeding to examine the two doctrines which at this day approach nearest to positive rationality,—that of definite proportions and the electrochemical theory,—I will indicate two points of doctrine which seem by their nature, to indicate with precision the true dogmatic formation toward which, the science as a whole, must tend.

Law of double saline decompositions.

First, there is a great law of double saline decompositions, discovered by Berthollet, and completed by M. Dulong's investigations on the reciprocal action of soluble and insoluble salts. The case of double solubility, considered by Berthollet, is this: two soluble salts, of any kind, mutually decompose each other whenever their reaction may produce an insoluble salt, or one less soluble than either of the two. This theorem stands first among general propositions in chemistry, and is the only one which can as yet give an exact idea of what, in chemistry, constitutes a true *law*. It has all the characters of a law: it relates to the proper subject of chemical science; it establishes a relation between two classes of phenomena before independent; and, above all, it admits of prevision of phenomena according to their positive relations. In establishing this law, Berthollet escaped some metaphysical snares, rejecting hypotheses of affinities; but he fell into one when he attempted to explain the law which he had just discovered. No law can be explained otherwise than by showing that it enters into another more general than itself: but this law of Berthollet's is alone of its kind; and it therefore admits of no explanation. It may hereafter be attached to a fundamental theory of the reciprocal action of all compounds of the same order; and such a relation will truly explain it: but at present it is simply a general fact which, inexplicable itself, serves to explain each of the particular facts which it comprehends.

Chemical theory of air and water.

The influence of air and water in the production of chemical phenomena is another of the most perfect doctrines of chemistry as it stands. The importance of the action of air and water in the terrestrial economy has induced some German philosophers irrationally to set up the system of these two fluids into a sort of a third reign, between the inorganic and the organic: but abstract chemistry has nothing to do with natural history, and regards the study of air and water from a different point of view, while aware of its fundamental importance.

All chemical phenomena takes place in the presence of air; and they almost invariably require the intervention of water; it is clear therefore that before we study any chemical reaction, we must be able to analyze the participation of these two fluids. Thus the chemical theory of air and water is a sort of necessary introduction to the system of chemistry, properly so called, as belonging more to method than to doctrine, and as immediately following the study of simple bodies. It is an historical fact that the double analysis of air and water marked the first great advance in modern chemistry.

Air.

The influence of the air, not less important than that of water in chemical phenomena, was less difficult to characterize: for the air is simply a mixture, and its chemical action is merely that of the gases which compose it, each of which acts as if it were isolated, allowing for the diminution of intensity from its diffusion, and for the very few cases in which the accomplishment of the proposed phenomenon determines the combination of the gases in an accessory way. Chemistry has only to analyze it, leaving all other study of it to the department of natural history. This analysis was effected in the early days of modern chemistry, except that there is still some uncertainty about the proportion of carbonic acid gas, and perhaps of some other more considerable principles, as, for instance, hydrogen, the existence of which begins to be generally suspected. Though no appreciable change in the composition of the atmosphere has taken place within half a century, it is impossible to conceive that some alteration must not happen, in some direction, in course of time, among the many perturbing influences which act upon the mixture. Their antagonism, and that of vegetable and animal action, partly neutralizes them: but the equilibrium can not be precise and continuous. Geological considerations and botanical fossils lead us to suppose that at some remote periods the composition of the air must have been sensibly different: and chemists themselves have actually established some slight periodical variations, dependent on the proportion of carbonic acid at different seasons. Our analytical resources are, however, very imperfect with regard to the accessory principles of the atmosphere; for chemists can ascertain nothing of the distinctions which are proved to exist in the best-marked localities, by their influences on living beings. The study of these variations, all-important in its way,—even as possibly indicating the limits of human life in a remote future,—belongs to natural history; and that is probably the reason why chemists trouble themselves so little about it: and if there is neglect, it should be charged upon the naturalists. It is true that a preparation is required for their order of study, like all others,—a provision of knowledge, rising from physiology to astronomy itself: but the research is not especially a matter of chemical duty.

Water.

The study of water requires much more extended and complex researches than that of the air; and it is indispensable to the general system of chemical science: for water being a real combination, and perhaps the most perfect known to us, may exercise chemical effects proper to itself, independently of those attributable to its elements, and apart from its importance as a solvent,—to say nothing of it as a simple mixture. Thus there are three aspects under which water must be considered by chemists, all distinct and all essential; and the appreciation of them has been slow and difficult, if even we may say that this fundamental examination is yet complete.

The analysis of water, represented by a quantity of hydrogen double in volume that of oxygen, and unquestionably confirmed by synthesis, is the finest of the early discoveries of modern chemistry, not only from the light it casts upon the whole of chemical phenomena and the general economy of nature, but also from its conquest of prodigious difficulties. In regard to the first view, chemical science leaves nothing to desire. Yet, a notion has arisen, in recent times, of the existence of a new and more highly oxygenated combination between the two elements of water, which may raise some interesting questions, not about the irreversible composition of water, but about the kind of chemical influence which is taken for granted in its decomposition and recomposition in a multitude of phenomena; and especially, about the true mode of union of oxygen and hydrogen in all substances, and above all in liquids, which can not be obtained without water. Some doubts have lately been proposed about this, which seem to me to deserve mature examination.

The dissolving action of water has been the subject of a long series of laborious researches, much less difficult, and not far from complete. Yet more attention ought to be paid than is paid to the fine experiment of Vauquelin, in which it is shown that water, saturated with one salt, remains capable of receiving another, and even acquires by that the singular property of dissolving a new quantity of the first. This experiment, which has been in a manner despised, seems to me of the first order in its way, and a fit basis of a series of interesting researches about the apparently capricious laws of solubility, the study of which is yet essentially empirical.

Chemists were long in conceiving that water, besides being a solvent, might act in a really chemical manner, otherwise than by its elements. It seemed as if a combination so eminently neuter must be inoffensive, and inoperative, except by its decomposition. It was Proust who thought that this neutrality itself afforded a presumption of certain chemical affections, independently of its composition. This was the rational consideration which led him to create the important study of the *hydrates*, regarded as a sort of new salts, in which water plays the part, with regard to the alkalies, of a kind of hydric acid.

The examination of these combinations, and of all others that water can form with any substances without being decomposed, constitutes the third and last part of the fundamental study of water, regarded as an indispensable preliminary to the general system of chemical studies.

CHAPTER III.

DOCTRINE OF DEFINITE PROPORTIONS.

THERE are two general doctrines in chemistry, as it now exists, which present a systematic appearance, and invest the science with such rationality as it has attained. The first of these is the important doctrine of Definite Proportions.

Scope of the doctrine.

Even if this doctrine were complete, it could exert only a secondary influence on the solution of the great problem of the science,—the study of the laws of the phenomena of composition and decomposition. The essential question is, what separations and new combinations must take place under determinate circumstances; and the theory of definite proportions affords no assistance to this kind of prevision. It proceeds, indeed, on the supposition that the question is already solved; and that it is to be taken as the point of departure for the estimate of each of the new products,—of their quantity and the proportion of their elements. Thus, the theory of the definite proportions presents the singular scientific character of rendering rational, in its numerical details, a solution which usually remains empirical in its most important aspect.

It was natural that the founders of modern chemistry should have attended to the laws of composition and decomposition, in preference to a study which they regarded as subordinate; and it was natural also that, as the advance of science disclosed to them the vast difficulties of the main problem, they should attend more and more to the secondary study, which promised an easier and more speedy success. But the most important office of this subordinate theory,—that of supplying the defect of immediate experiment,—can be but very imperfectly fulfilled, while it is regarded apart from the principal theory; and thus, the doctrine of definite proportions will never require its full scientific value till it is connected with an unquestionable basis of chemical laws, of which it will be the indispensable numerical complement.

Meanwhile, however, it affords a real, though secondary assistance to chemists, in rendering their analyses more easy and more precise. Moreover, it restricts the number of cases of combination logically possible, by exhibiting the very small number of distinct proportions; and by thus diminishing the uncertainty in cases of chemical action, it is, in fact, a natural preliminary to the establishment of those chemical laws to which it will be, under another view, a necessary supplement.

As to doctrine.

As to method.

In regard to doctrine, this theory offers a perfect type of the precise kind of rationality which must hereafter belong to Chemistry as a whole. In regard to method, the inquirers who have devoted themselves to establish the theory have advanced chemical science while appearing to diverge from it; simplifying the vast problem which their successors will solve, and preparing for the disclosure of the great laws of composition and decomposition, which would be undiscoverable amidst the infinity of products, if substances could combine, within certain limits, in all imaginable proportions. Such are the claims of this theory, as to doctrine and to method.

Its history.

Richter's law.

It assumed its existence and present form during the first quarter of this century: and it arose from a phenomenon discovered by Richter, and a speculative discussion established by Berthollet.—During the latter half of the last century, several chemists had observed that, in the mutual decomposition of two neutral salts, the two new salts thus formed are always equally neuter. Bergmann, among others, had steadily and specially dwelt upon this. Yet the fact was neglected or underrated till Richter, at the end of the century, generalized the observation, saw what it imported, and derived from it the fundamental law which bears his name. The law is this: that the ponderable quantities of the different alkalies requisite to neutralize a given weight of any acid are always proportionate to those required for the neutralization of the same weight of every other acid. This is, in fact, evidently the immediate consequence of the maintenance of neutrality after the double decomposition. Such a transformation would appear almost spontaneous if it related to a simpler and more developed science than Chemistry; but amidst its complications and the imperfection of our intellectual habits, the closest deductions are difficult if they have any character of generality, and therefore of abstraction; and this achievement of Richter's is, in consequence, eminently meritorious, on other grounds than its high utility.—His law, with the complements it has since received, is the original basis of the general doctrine of definite proportions. It exhibited, in the case of a considerable number of compounds, the great end of this doctrine;

viz. the assignment to every substance of a certain chemical coefficient, invariable and specific, indicating the proportions in which it can combine with each of those that have been similarly characterized. When it had been determined, by a double series of trials, what was the numerical composition of all the salts that may be formed by any one acid with the different alkalies, and any one alkali with the different acids, Richter's law enabled us to deduce immediately the proportions relating to all the compounds that can result from the binary combination of these two orders of substances. Richter himself brought his discovery up to this result, and prepared (but on a basis of experiment too narrow and imperfect) the first table of what were afterward called *chemical equivalents.*

Berthollet's extension.

These neutral salts constituted a particular case, which could hardly have led on to a general theory of definite proportions. The idea of perfect neutralization must probably, at all times, have suggested to chemists that of a single proportion, on either side of which the neutrality must be destroyed; and thus the neutral salts were a natural first stage of the general theory; but they could not in themselves involve such a theory. It was Berthollet who extended the consideration of proportions to the whole of chemical phenomena. Some years after Richter's discovery he established as a fundamental principle, in his "Chemical Statics," the necessary existence of definite proportions for certain compounds of all orders; and he assigned the essential conditions of this characteristic property, which he attributed to all causes which can release the product of chemical reaction, as it forms, from the ulterior influence of the primitive agents. He thus added to Richter's restricted case the idea of a great number of cases subjected to the same principle, and able to lead on to its entire generalization. It is assigning much too little honor to Berthollet to recognise only the influence of his controversy with Proust, eminent as was the service rendered by Proust in that conflict, in establishing directly the general principle of determinate and invariable proportions.

Dalton's further extension.

Such was the double origin, experimental and speculative, of numerical chemistry. The next development had also a double character, arising from the harmony between the conception of Dr. Dalton and the experimental researches of Berzelius, Gay-Lussac, and Wollaston. The inquiry was in a nascent state when Dalton's philosophic mind discerned its possible generality. He proposed the great Atomic theory, under which the doctrine of definite proportions was developed to the whole extent that it has reached, and which serves as the basis of its daily application. The general principle of the theory is this: all elementary bodies are conceived of as formed of individual atoms, the different species of which unite, generally by twos, in a small number of groups, constituting compound atoms of the first order always mechanically indivisible, but thenceforth

Atomic theory.

chemically divisible, and, in their turn, constituting all the other orders of composition by a series of analogous combinations. The principle is in such harmony with scientific conceptions in all departments, that it appeared like a happy generalization of the most familiar ideas of scientific men in every province of natural philosophy; and its universal and immediate admission took place as a matter of course.

It was observed by Berzelius that the deduction of the existence of definite proportions from this principle would be illusory if the combinations were not restricted to a very small number of atoms: for otherwise—if the number was, though limited, very great—the binary assemblages would be so multiplied that we might as well have combinations in any proportions whatever; and then the atomic theory might almost equally well represent the opposite doctrines of definite and indefinite proportions. Dalton was well aware of this; and the restrictions that he enunciated were presently declared too narrow by his successors, who found that they would not comprehend all existing combinations. His assertion was, that, in every combination, one of the immediate principles always enters for a single atom, and the other generally for a single atom also, and always for a very small number, rarely exceeding six. Taken with the expansion proposed by his successors, the atomic conception evidently represents the entire doctrine of definite proportions. But it is the theory of successive multiples, derived from the primary doctrine, which especially distinguishes Dr. Dalton's influence upon numerical chemistry. From the ground of his doctrine he easily saw that if two substances can combine in various distinct proportions, the ponderable quantities of the one which correspond, in the different compounds, to the same weight in the other, must naturally follow the series of whole numbers, since these compounds will have resulted from the union of one atom of the second substance with one, two, three, etc., of the first: and this constitutes a principal element, then perceived for the first time, of the theory of chemical proportions.

Extension by Berzelius.

Berzelius followed, with his vast experimental study of the whole of the important points concerned in numerical chemistry, the different parts of which he has done more than any other chemist to develop and systemize. He first perfected Richter's law, so as to connect it closely with the atomic theory; by which it became susceptible of the extension given to it by Berzelius himself, to all compounds of the second order. But the most important new knowledge has arisen from his numerical study of compounds of the first order. By comparing the composition of the metallic sulphurets and that of the corresponding oxydes, he discovered a law, analogous to Richter's in regard to the salts. This law—that the quantity of sulphur of the first is always proportionate to the quantity of oxygen combined with a like weight of the base in the second—is now regarded, by induction, as applicable to all the compounds of the first order to which the same degree of chemical neutrality is assignable. And again the luminous series of the analyses of Berzelius have precisely verified in another direction the law of successive multiples discovered by Dalton in pursuance of his atomic theory.

Extension by Gay-Lussac.

Gay-Lussac followed, with the valuable numerical analyses he effected by having recourse to gaseous combinations, considered, not as to weight, but to volume. He thus not only verified, in a special manner, the general principle of definite proportions, but presented it under a new aspect, which, by a wise induction, comprehends all possible cases—showing that all bodies in a gaseous state combine in invariable and simple numerical relations of volume. An accessory advantage of this achievement was that the specific gravity of the gases might be obtained with a precision often comparable to that of experimental estimate. It is necessary however to warn inquirers not to be led away. in their application of the theory of volumes to substances which have never been vaporized, from the point of view which in Gay-Lussac's application is equivalent to Dalton's, as adopted by Berzelius.

Wollaston's verification.

The labors of Wollaston bore a great part in establishing the doctrine of definite proportions. I do not refer chiefly to his transformation of the atomic theory into that of chemical equivalents, though it has a more positive character, and tends to restrain the student from wandering after inaccessible objects, to which the first might tempt him, if not judiciously directed. The substitution would be of high value, no doubt, if it were not less a change of conception than an artifice of language. Nor have I in view the ingenious expedients by which Wollaston popularized numerical chemistry by rendering its use more clear and convenient. A greater service, in our present view, was his furnishing us with the indispensable complement of Richter's discovery, by establishing the theory in regard to the acid salts, since extended by analogy to the alkaline salts. The case of the acid salts was perhaps the most unfavorable possible for the ascertainment of the principle of invariable proportions. Wollaston effected the proof in the most satisfactory manner; and this special confirmation of the principle is considered, from its nature, the most decisive of all.

Such has been the logical and historical progress of the researches which have constituted numerical chemistry as it is now. We can represent by an invariable number, appropriated to each of the different elementary bodies, their fundamental relations of chemical equivalence, whence, by very simple formulas, immediately expressing the laws just indicated, we easily pass to the numerical composition proper to each combination. No further evidence of the truth of the doctrine is needed, than the fact that so many illustrious inquirers having attained the same view by ways which each one opened for himself, and all agreeing as to its positive application to all cases of importance, differing only as to the mode of expression of the results, in as far as the atomic theory left it indeterminate, and therefore optional. But we must glance at the dif ficulties thrown in the way of its application by a consideration of the aggregate of chemical phenomena, in order to form a clear idea of the final improvement of which this doctrine yet stands in need.

Scope of application of Numerical Chemistry.

Among the points which are beyond dispute, it is, first, evident, and no chemist has ever doubted it, that substances differ as much in the proportion as in the nature of their constituent principles. It is an axiom of chemical philosophy that any change whatever in the numerical composition causes a change in the whole of the specific properties, in a more marked degree as the alteration is greater. Varied and gradual above all others as are the proportions produced by the chemical phenomena proper to living bodies, they afford a striking confirmation to this universal maxim. Therefore, in the lowest stages of chemical analysis, chemists have always endeavored to assign, as a characteristic property, the proportion of the elements of each substance, as far as possible: and when this was omitted, it was on the understanding that the proposed combination admitted of only a certain proportion; as in the case of the neutral salts.

Again, it has long been acknowledged that there always exists, between any two substances, a certain minimum and maximum of reciprocal saturation, beyond or short of which all combination becomes impossible. At the utmost, certain variations, themselves restricted, have been supposed procurable. Berthollet established, more directly than any one else, the general and necessary existence of these limits of combination—one of the principal characters which distinguish it from simple mixture. It is clear that the two extreme degrees of all combination must be subject to special and invariable proportions: and, as all agree in this, all argument, about the opposite doctrines of indefinite and definite proportions is reduced to the question whether the passage from the minimum to the maximum of saturation can be effected gradually and almost imperceptibly, or whether it takes place always abruptly, through a small number of well-marked degrees.

Thirdly, the possibility and actual existence of intermediary definite proportions are admitted by all chemists, who can have no other dispute than about the greater or small generality of such a property. We have seen that the idea of neutrality must, sooner or later, bring after it that of a determinate and unchangeable proportion; and the gradual development of chemical knowledge has extended this character to more and more varied cases. Berthollet disclosed several other causes of definite proportions, which were entirely misconceived before his time, and which may meet in almost all combinations, modifying certain circumstances of the phenomenon. The precise question now is, therefore, whether, besides these determinate compounds, subject to fixed proportions, within the two limits of possible combination, there does or does not exist, in general, a continuous series of other intermediate compounds of a less marked character; in a word, whether definite proportion constitutes the rule, as is now generally supposed, or, as

Berthollet endeavored to establish, the exception. This is now the only dispute. It is no derogation from the interest of the doctrine of definite proportions to say, as some preceding considerations compel us to do, that the decision of this disputed point is not of the importance commonly supposed. The doctrine has tended to simplify the general problem of chemistry; but it must not be supposed that the solution would have been impossible without this aid:—it would have been simply more difficult and less precise. The eminent chemists who concurred in establishing the doctrine were naturally engrossed by that labor; but their successors, who find numerical chemistry constituted to their hand, must beware of losing sight in it of the true scientific aim of chemistry. They must not linger in this vestibule of the science, to the neglect of the direct construction of Chemistry itself —an enterprise scarcely begun, and to which it is high time that attention should be once more fully directed.

If we inquire, as we must do, how far the doctrine of definite proportions is irrevocably established, we shall bear in mind that the founders of numerical chemistry have accomplished that chief part which depends on an investigation of all known compounds, leaving only the question whether the doctrine is compatible with certain chemical phenomena, neglected during its formation, and remaining to be since referred to it.

Objection of dissolution.

The first general objection relates to the important phenomenon of dissolution, evidently possible in an infinity of different proportions. It must be acknowledged that the distinctions between the state of dissolution and that of combination, by which the difficulty has been met, afford little satisfaction. In my opinion the only effectual reply must consist in the extension of the principle of definite proportions to the phenomena of dissolution; and, difficult as it may be to do it, it does not seem to me impossible. The way is by the use of an hypothesis already proposed for other cases in which it might appear less admissible. All the successive degrees of concentration of the liquid must be regarded as simple mixtures of the small number of definite dissolutions which shall have been established, either between themselves or with the dissolvent, in the manner of habitual mixtures of water with alcohol, with sulphuric acid, etc. In any case, the positive verification of this hypothesis must be extremely delicate. Furthermore, to render the study of dissolutions fully rational, in this point of view, it is necessary to combine with it that of other analogous chemical phenomena, relating to the absorption of gases by liquids or by porous solids. All these different modes of molecular union are often energetic enough to resist influences able to destroy certain combinations, properly so called: why should they not be, like them, subject to the rule of definite proportions, if that rule is truly a fundamental law of nature?

Of metallic alloys.

The next case, that of various metallic alloys, is very extensive, though more particular. The difficulty lies in the question whether these are cases of combination or of mixture. The state of combination has been taken for granted in the case of alloys; whereas the general application of the principle of numerical chemistry requires that they should be mixtures; while, again, it is difficult to conceive of such a mixture of solids as could resist perturbing influences which would appear to be necessarily destructive; as great changes of temperature, the influence of crystallization, etc. The question can be decided only by a series of special experiments, devised to find the general limits of the permanence of unquestionable mixtures; and the results might be extended to other questions of numerical chemistry, as of certain oxydes, on which explanations have been hazarded too freely. When a true chemical theory of mixtures is established on a proper basis of experiment, and we leave off referring to an hypothesis of mixture all cases in which combination seems susceptible of an indeterminate proportion, in order to bring them under the law of definite proportions, we shall get rid of a formidable objection to the principle of numerical chemistry.

Of organic substances.

The remaining case constitutes the greatest obstacle of all in the way of the generalization of the law of definite proportions; and if it can not be surmounted, the law sinks to the rank of an empirical rule, fit for nothing more than facilitating a certain order of chemical analyses. I refer to the class, anomalous in this view, of substances called organic. And this is the effect, in fact, of the declaration of the chemists of our time, that organic substances do not come under the principle of definite proportions. It amounts to saying that the law rules all the elements, except oxygen, hydrogen, carbon, and azote. The division between inorganic and organic chemistry is merely scholastic; for all chemistry is, by its nature, homogeneous—that is, inorganic. And thus, if we admit of the enormous exception of the numerical composition of so-called organic substances, the doctrine of definite proportions is overthrown as a rational theory. As it evidently can not be founded on any *à-priori* considerations, it is only by a strict generality that it can become a rational theory.

Application of the principle of dualism.

If we could not hold at once the grand principle of the dualism which pervades chemistry, and constitutes its homogeneous character, and the doctrine of definite proportions, I should not hesitate to sacrifice the latter; for it is more important for chemical progress to grasp the great principle of systematic dualism, than to advance our investigations by the use of the numerical rule. But there is not, in fact, any incompatibility between these two means of progress; and such a brief sketch of my conception on this subject as my limits allow may show how the doctrine of definite proportions can be duly generalized only by discarding organic chemistry as a separate body of doctrine, and extending the principle of dualism to all organic compounds.

If we are to include all organic compounds under one uniform system of chemistry, properly so called, we must refer to physiology, vegetable and animal, the study of the numerous secondary substances which owe their transient and variable existence to the development of vital phenomena, and which have no scientific interest except under the head of biology. We shall see, under that head, hereafter, what the precise classification is; and all that we have to do with it now is to show that it proceeds from the fundamental distinction between the state of death and that of life. The second, and most extended class of organic substances is chiefly composed of mixtures which, as such, admit of all imaginable proportions, within the limits of vital conditions. As for the substances which exhibit real combinations, we must conceive of them as subject to the law of definite proportions; but the complexity, and yet more the instability of such compounds will probably for ever forbid their being successfully studied under the numerical point of view, which is indeed of very inferior interest in biology. Even after this clearing of the field, we could not accomplish the desired generalization if we had not taken a new stand with regard to the ternary and quaternary substances contemplated by ordinary chemistry. The rigorous dualism which I have before, and in a higher view, shown to be necessary, seems to supply, naturally and finally, the needs of the doctrine of definite proportions.

As long as chemists persist in regarding organic combinations as ternary and quaternary—that is, in confounding their elementary with an immediate analysis;—while oxygen, hydrogen, carbon, and azote, are regarded as immediately united, the compounds from them which must be recognised as distinct, after the severest sifting, will be enough to constitute an invincible objection to the principle of a numerical chemistry. But if they become binary compounds of the second, or at most the third order, whose principles are formed by the direct and binary combination of those three or four elements, we find ourselves able to represent all the actual numerical varieties established by an elementary analysis, conceiving, for each degree of combination, a very small number of distinct and entirely definite proportions. In the ternary case—appropriate to compounds of a vegetable origin—their three elements may be united in three kinds of binary combinations. Combining these again, still employing at once oxygen, hydrogen, and carbon, we have three principal classes of compounds of the second order. But then, again, each term of the new compounds really corresponds to two distinct substances; and thus, while admitting only one proportion for the binary composition of these bodies, we have already provided for the numerical composition of twelve substances at present called ternary. But, further, we are compelled to suppose at least three different proportions for each binary combination; one producing perfect neutralization, and the other two the extreme limits of the reciprocal saturation; and chemical analogies indicate a much larger number of compounds. Putting those aside, we have thirty-six compounds, without going beyond the second order, by the known combination of three elements on the principle of dualism. We are also entitled now to conceive of a third possible combination between oxygen and carbon, or between carbon and hydrogen, etc., which already furnish two, after being long supposed to admit of only one. Hence, and in view of all these considerations, we may be assured that by dualism we might completely and naturally subject to the law of definite proportions eighty-one compounds of the second order, formed from oxygen, hydrogen, and carbon; and this would unquestionably more than suffice to represent the elementary analysis of all distinct substances in the range of vegetable chemistry.

Passing on to the quaternary case, characterizing what is called Animal Chemistry,—it seems as if the principal class of compounds of the second order must be more numerous than in the ternary case: but the indispensable condition of employing all the four elements at once restricts the classes to three. But when we examine the terms of the secondary compounds, we find that while two represent only one compound each, a third represents five. Thus, the three pairs of compounds yield fourteen of one proportion, and forty-two of the three proportions indicated in the last case. But applying, at each degree, the rational rule of a triple binary combination, without stopping at the inevitable gaps of our existing chemistry, we find ourselves in possession of ninety-nine compounds of the second order, now regarded as quaternary. This is probably a larger number than a rational analysis of animal substances will be found to require. Morever, as animal substances have undergone a greater degree of vital elaboration than vegetable matters, it would be philosophical to admit, with respect to them, the possibility of a higher order of composition, such as physiological combinations must eminently tend to realize. On such an hypothesis, without going beyond the third order, we might obtain ten thousand perfectly distinct compounds from these four elements, all formed by an invariable dualism, and strictly subject to the law of definite proportions. It is true, nature would not permit the realization of more than a small part of these speculative combinations; but I have pursued the consequences of my conception to this extreme ideal limit, to show how abundant are the rational resources supplied by this new theory for the generalization of the laws of numerical chemistry. If this view is not followed up, or some equivalent one proposed, it is evident that we must give up the doctrine of definite proportions as a law of natural philosophy, and return to Berthollet's theory, merely enlarging the cases of fixed proportions which he admitted. In the present state of the question there is no other choice. But my theory having been, not instituted for this destination, but naturally arrived at by another way, and with higher views, and proceeding from established principles, to meet the needs of chemical philosophy, seems to me to be presumptively entitled to a future, and perhaps speedy realization.

This account of the present aspects of the doctrine of definite proportions will enable any one to judge of its real progress from its institution to this day; of the conditions which must be fulfilled before its principle can be converted into a great law of nature; and of the rational course which alone can lead to such a final constitution of numerical chemistry.

CHAPTER IV.

THE ELECTRO-CHEMICAL THEORY.

Relation of Electricity to Chemistry.

FROM the beginning of modern chemistry, the chemical influence of electricity manifested itself unequivocally in many important phenomena, and, above all, in the grand experiment of the recomposition of water by the direct combination of oxygen with hydrogen, effected by the aid of the electric spark. But the special attention of chemists was not strongly drawn toward this agency till Volta's immortal discovery disclosed its principal energy, in rendering the electric action at once more complete, more profound, and more continuous. Since that time, various series of general phenomena have taught us that electricity is a chemical agent more universal and irresistible than heat itself, both for decomposition and combination. The danger now is of exaggerating the relation it bears to the general system of chemical science. Though chemistry is united to physics by this agency more than by any other, it must yet be remembered that the two sciences are distinct, and that there should be no no confounding of chemical with electrical properties. In order to ascertain with precision what are the relations of chemistry with electrology, we must briefly review the gradation of ideas which have led up to the present electro-chemical theory, as systemized by Berzelius.

History of the case.

Nicholson's discovery.

The first important chemical effect of the Voltaic influence was the decomposition of water, established by Nicholson in 1801. It was a necessary result of examination into the action of the pile, without any chemical intention. It confirmed a truth before well known: but it had a high chemical value, as revealing the chemical energy of the instrument; and it thus constituted the starting-point of electro-chemical research. We may even refer to this origin the first attempts at founding a general theory of electro-chemical phenomena; for the conception offered by Grothuss, to explain Nicholson's observation by the electric polarity of molecules, contains the germ of all the essential ideas which have expanded, according to the requisitions of the phenomena, into the present electro-chemical theory.

The analytical power of the Voltaic pile having been once discov-

Davy's discovery.

ered, it was natural for the chemists to apply the new agent to the decomposition of substances which had hitherto resisted all known means. The first series of attempts produced, after a few years, the brilliant discovery by the illustrious Davy, of the analysis of the alkalies, properly so called, and the earths. Lavoisier's theory, which showed that every salifiable base must be a result of the combination of oxygen with some metal, had foreshown this analysis; but no chemical means had sufficed to effect it. It was believed in, in spite of Berthollet's discovery of the true composition of ammonia; and the brilliant result obtained by Davy was an easy consequence of a discovery completely prepared for. M. Gay-Lussac soon followed, with a more difficult but less striking achievement—the confirmation, by a purely chemical process, of the electrical analysis of potash.

Berzelius's extension.

Nicholson's observation having originated electro-chemistry, and Davy's given it a great impulse, the next step was to investigate the chemical influence of electricity, in a scientific view. This was effectually, though indirectly, determined by Davy's great feat; for by it chemistry was proved to have achieved the most important, and hitherto inaccessible analyses: and, in fact, the science has not since made any essential acquisition. Electro-chemical action was presently and permanently subjected to direct and regular study; and it was irrevocably constituted a fundamental part of chemical science when Berzelius accomplished his series of investigations on the Voltaic decomposition of all the salts, and then of the principal oxydes and acids. It was in consequence of these researches that the habitual consideration of electric properties has assumed a growing importance in the chemical study of all substances, which are now scientifically divided into the classes of electro-negatives and electro-positives. It was thus the privilege of Berzelius to be the first to conceive of the electro-chemical theory under an entirely systematic form.

Synthetical process.

Becquerel's.

One condition remained to be fulfilled, to give its due scientific character to this new branch of chemistry. The Voltaic action had thus far been regarded only analytically:—it must be regarded synthetically also. This was done by the labors of Becquerel, who fully established the synthetical influence of electricity, fitly applied; and who, moreover, employed it in effecting new and valuable combinations, hitherto impracticable. From this procedure arose the necessity of modifying the method of experimentation. The apparatus which was powerful enough to decompose was much too powerful to combine, because it would probably decompose the immediate principles which were intended to be combined; and thence arose the method of employing the protracted action of very feeble electric powers,—every advantage being given to the disposition of the substances to be acted upon. M. Becquerel did this very successfully by operating with a single Voltaic element, and seizing each substance in the state called *nascent*, which is agreed upon as most favor able to combination. This change of procedure is the distinctive honor of M. Becquerel. He not only determined direct combinations, not before obtainable, but exhibited in others, which were obtainable, the remarkable property of clearly manifesting their geometrical structure, through the slowness and regularity of their gradual formation;—a character especially marked in the case of certain metallic sulphurets, some oxydes, and several salts. It does not lie within our province to point out the results of this method in regard to the natural history of the globe, in explaining a great number of mineral origins, when the time for such concrete questions shall have arrived. It is more in our way to observe the importance of these labors in bringing up chemical synthesis to something like harmony with the progress of analysis,—favored as the latter pursuit had been by the ease with which we destroy, in comparison with the difficulty with which we recreate. Once more, these researches of M. Becquerel have completed the general constitution of electro-chemistry, which, being henceforth at once synthetical and analytical, can only expand in one of these two directions, however great the improvements remaining to be attained.

Such has been the filiation of electro-chemical discoveries, since the beginning of our century. A little attention to the great phenomenon which was the original subject of the electro-chemical theory will show how this study has gradually led to a new fundamental conception for the whole of Chemistry.

Study of combustion.

It has been said, through all periods of chemical research, that the study of Combustion must be the central point of the science. So it was thought in the ancient theological period of the science; and also in the more recent metaphysical stage, when combustibility was called phlogiston, and regarded as an intangible materialized entity: and the advent of the positive period of chemistry was marked by the establishment of Lavoisier's new theory of combustion. In our day it is the recognised necessity of modifying this theory that has especially led to the electric conception of chemical phenomena.

Lavoisier's theory.

The pneumatic theory of combustion of Lavoisier had two entirely different objects in view; objects which are too commonly confounded, but which we must be careful to keep apart. First, the analysis of the general phenomenon of combustion: and, secondly, the explanation of the effects of heat and light, which is, in the eyes of the vulgar, the more important of the two. Both were treated in the most admirable manner possible in the existing state of knowledge; and in the characteristics of positivity and rationality Lavoisier's theory has not since been surpassed. All combustion, abrupt or gradual, was regarded as consisting in the combination of the combustible body with oxygen, whence, when the body was simple, must result an oxyde, generally susceptible of becoming the basis of a salt, and, if the oxygen was preponderant, a true acid, the principle of a certain kind of salts.

As for the disengagement of heat and light, it was attributed, in a general way, to the condensation of the oxygen, and in an accessory way, to that of the combustible body, in this combination.

First division.

The first part of this anti-phlogistic theory has a much more philosophical character than the second. It was eminently rational to analyze the phenomenon of combustion, so as to seize whatever was common to all cases. The conclusions drawn might be too general; and were afterward proved to be so; but whatever would stand the test of time must form a body of indestructible truth, constituting an essential part of chemical science through all future revolutions. The case is different with the explanation of heat and light. The question is not, like the first, of a chemical, but a physical nature; and, whatever may be its final solution, it can not affect chemical conceptions. It would have been wiser to abstain from offering any general explanation of the effects of heat and light through such a supposition as that of a condensation, which does not necessarily take place, and which is, in fact, found to be often absent. Lavoisier hoped to attach the thermological effect to the great law discovered by Black, of the disengagement of heat proper to the passage of any body from one state to another more dense; but such a connection could not be established on the ground of phenomena not invariably present, or indisputably manifested. However, it would be too much to expect a perfect scientific reserve in discoverers who bring out the scientific truths from a region of metaphysical phantasies. It is from their followers that we have a right to demand it; and we are compelled to charge upon the chemists who have been eager to substitute the electro-chemical theory for the anti-phlogistic theory, properly so called, a want of care in constructing explanations analogous to those which are dismissed as insufficient. To justify this charge, we must review the proofs of the imperfection of Lavoisier's theory,—still regarding it under the two divisions just exhibited.

Berthollet's limitation.

Berthollet saw presently that Lavoisier's method of analysis of combustion must be modified. One of the chief consequences of this analysis was that every acid and every salifiable base must be a result of combustion; that is, of the combination of any element with oxygen; whereas, Berthollet discovered that one of the most marked of the alkalies, ammonia, is formed of hydrogen and azote alone, without any oxygen; and soon after, he proved that sulphuretted hydrogen gas, in which also there is no oxygen, nevertheless presents all the essential properties of real acid. These facts have since been confirmed in every possible way, and especially by the elecric method; and the exceptions, both as to alkalies and acids, have become so multiplied, that the investigation and comparison of them have given that high character of generality to the study of alkalies and acids which belongs to it in our time.

Moreover, the primitive theory of combustion has been gradually modified by the discovery that a rapid disengagement of heat and light is not always an indication of a combination with oxygen. Chlorine, sulphur, and several other bodies, even non-elementary, have been found to occasion true combustion. And again, the phenomenon of fire is no longer attributed exclusively to any special combination, but, in general, to all chemical action at once very intense and vivid.

It does not follow that because Lavoisier's discoveries have parted with some of their character of generality, they have lost any of their direct value: and such alteration of views as there is relates chiefly to artificial phenomena, while the natural facts remain securely established. Thus, though there are acids and alkalies without oxygen, it is unquestionable that the greater number of them, and especially the most powerful, are oxygenated: and again, if oxygen be not indispensable to combustion, it remains the chief agent, and especially in natural combustions. In natural history, the theory is applicable, almost without reserve, though it is insufficient for the severe conditions of abstract science. If the universal sovereignty of oxygen has been overthrown, it will yet be for ever the chief element of the whole chemical system.

Second division.

As for the second aspect of the discovery,—the explanation of fire,—it was destroyed by the first direct examination of it. No new facts were required for its overthrow, but merely a more scientific appreciation of common phenomena. It will not even serve naturalists for their concrete purposes in any degree, having never really explained the most ordinary effects. The required condensation is found to be only occasionally present, and often absent in the most important cases; so that if it were not for the connection of this aspect of the theory with a sounder one, it would be inconceivable how it could have held its ground up to a recent period,—busy as the chemists were with other theoretical speculations. After finding that in cases where condensation was supposed, expansion exists instead; and that where we find vivid combustion, there should, by the theory, be a great cooling, we are brought to the reflection that if the fire on our hearths was not a matter of daily fact to us, its existence must become doubtful, or be disbelieved, through those very explanations by which the phenomenon has been proposed to be established. To my mind, this is a clear indication that the chemical production of fire does not admit, in a general way, of any rational explanation. Otherwise it appears incomprehensible that men of such genius and such science, at a time so near our own, should have been so deluded. The electric fire, now proposed for an explanation, must have been sufficiently known to Lavoisier, Cavendish, Berthollet, and others, to have served as a basis to their theory, if its preponderance over the merits of their hypothesis had been so great as is now commonly supposed. This consideration however, striking as it may be, is no dispensation from the duty of examining the electro-chemical conception, for which we have been prepared by this short account of its antecedents.

According to this theory, the fire produced in the greater number of strong chemical reactions must be attributed to a real electric discharge which takes place at the moment of combination (by the mutual neutralization, more or less complete, of the opposite electric conditions) of the two substances under consideration,—one of which must be electro-positive, and the other electro-negative. There is every reason to fear, however, that when this theory has been effectually examined, it will be found as defective in rationality as its predecessor. If electric effects are concerned in all chemical phenomena, as seems to be now agreed upon by most chemists and physicists, they must oftener be supposed than found: and the electric symptoms are most impossible to detect in precisely those chemical phenomena which have been most relied on for overthrowing the old theory. And in the cases in which electrization is evident, its chemical influence is so equivocal that some regard it as the cause, and others as the effect, of the combination. The explanation is not yet positively established for any phenomenon that has been duly analyzed: while its vague nature leaves room for fear that it will not be so radically or so speedily destroyed as its predecessor. It could be plainly shown whether the requisite condensation did or did not exist; but there is always a resource, in the more recent case, in the faint or fugitive character of the electric condition, which defies our means of positive exploration,—qualities which are far from being a ground of recommendation of a theory which is to account for very striking and intense effects. I do not desire to say that the disengagement of light and heat can never have an electric origin, any more than that it can never proceed from the condensation proposed: but I think an impartial observation would decide, that in most cases of combustion there is neither condensation nor electrization. My own view is that these vain attempts to explain the chemical production of fire proceed from the lingering metaphysical tendency to penetrate into the nature and mode of being of phenomena: and that chemical action is one of the various primitive sources of heat and light, which can not, from their nature, usually admit of any positive explanation; that is, of being referred, in this relation, to any other fundamental influence.

Difficulties of the theory.

If our chemical science were more advanced than it is, we should not have to point out that the consideration of fire, which, however important, is only a physical accessory of chemical phenomena, can not afford a rational ground for a radical change in our conceptions of chemical action. When our predecessors regarded heat as the chief physical agent in composition and decomposition, they did not pervert such a consideration to the point of assimilating chemical to thermological effects. We are less cautious at the present day: we confound the auxiliary, or the general physical agent of the phenomenon, with the phenomenon itself, and pervert chemistry by confounding it with electrology, by irrationally assimilating chemical to electrical properties, as is seen especially in the theory of M. Berzelius. How can there be any scientific comparison between the tendency of two bodies to a mechanical adhesion after a certain mode of electrization, and the disposition to unite all their molecules, external and internal, by a true chemical action? M. Berzelius has frankly declared that cohesion, properly so called, admits of no electric explanation. Nothing is gained toward explaining the molecular connection, indissoluble by any mechanical force, in contrast with the magnetic union so easily overcome, by talking of Voltaic elements with their positive or negative pole, and their connection by the electric antagonism of the opposite poles. Such inventions give no idea whatever of molecular cohesion. Nor is affinity, or the tendency to combination, any better explained by the electro-chemical theory. Electrical phenomena, in physics, are eminently general, offering only differences of intensity in different bodies; whereas, chemical phenomena are essentially special or elective: and therefore every attempt to make chemistry, as a whole, enter into any branch of physics, is thoroughly anti-scientific. This would be enough: but we see, besides, that the smallest changes in the mode of electrization reverse the electric antagonism, and destroy the proposed electrical order of elementary bodies: we find ourselves unable to deduce the new electric properties which the theory bids us look for in the compounds of different orders; we do not know by what laws they derive their positive or negative character from the electric condition of each of the two elements; nor are we able to approach the great end of chemical science,—the prevision of the qualities of compounds by those of their constituent elements. Morever, in any case, the great body of chemical phenomena opposes insurmountable obstacles; as when oxygen, the most negative element, when entering largely into certain oxydes, finds them positive toward certain acids, into which it enters much more sparingly,—the radicals of the first being often as negative as those of the last. According to M. Berzelius's own frank declaration, organic compounds cast insuperable difficulties in the way of his arrangement of electric relations; and he alleges the transience of the combinations in that class of cases as an explanation of the anomaly: but chemical science would be impossible if compounds were not throughout considered stable till causes of decomposition arise: and if organic compounds are guarded from these, they remain chemically stable, like inorganic substances. The fundamental obstacle of the whole case—the identity of the elements, in opposition to the electric variety—can not, by any means whatever, be got over.

Leaving all these difficulties on one side, we learn nothing about chemical phenomena by likening them to electric action, for we establish thus no harmony between the pretended causes and the real effects. Every attempt seems to prove simply the auxiliary influence of electricity on chemical effects,—acting as heat does, only with a differet intensity. In fact, there are scarcely any electrochemical combinations which can not be effected by ordinary chemical processes, without any electric indications; and the few exceptional cases still existing may, by analogy, be expected to be brought under the rule. If, in the face of all this, we were to persist in investing the electrical influence with the specific and molecular attributes of chemistry, we should merely be restoring the old entity of *affinity*, decked out with some hypothetical material attributes, which would be far from rendering it more positive: and such a procedure would be as hurtful to physics as to chemistry, by infusing new vagueness into our notions of electricity, which are at present far from being sufficiently distinct. And then might follow, as likely as not, the founding on electrology, not only the whole of chemistry, but the theories of heat, of weight, and probably, as a consequence, that of celestial mechanics. And then, if we added to this heterogeneous assemblage a confounding of the supposed nervous fluid with the pretended electric fluid, we should have attained to the show of a universal system, devoid of all scientific use, which would fall to pieces as soon as tested by real study, parting off into categories of independent doctrine, and encumbering natural philosophy with insoluble questions, which must be discarded, to enable us to begin afresh.

Thus, to sum up, the great chemical influence of electricity, like that of weight, and yet more of heat, is unquestionable; and I have endeavored to exhibit the high importance of electro-chemistry to the improvement of chemical science, of which it is one of the essential elements. But I must, once for all, reject the conception through which it has been attempted to transform all chemical into electrical phenomena. In a philosophical point of view, Lavoisier's theory appears to me, notwithstanding its serious imperfections, very superior as a scientific composition to that to which it has given place. It related directly to the aim of chemical science,—the establishment of general laws of composition and decomposition; whereas the newer theory draws attention away from it, in a vain inquiry into the intimate nature of chemical phenomena. Thus the anti-phlogistic conception has suggested numerous and important chemical discoveries, while it is very doubtful whether as much will ever be said for the electric theory. In an indirect way, however, it may operate favorably for chemical science, by its binary antagonism suggesting the extension of dualism among compounds which are as yet supposed to be more than binary. Berzelius appears to have felt this connection; and he would probably have erected dualism into a fundamental principle, but for his subjection to the old division of chemistry into organic and inorganic. Others, who are free from this entanglement, may be prepared by the electro-chemical theory for general dualism: though it is not, in principle, desirable to recur to faulty means to attain good results in an indirect way. In another view, this the-

Its position and powers.

ory may be useful,—in fixing the attention of chemists on the influence of time in the production of chemical effects; an influence remarkably manifested by many phenomena, but not, as yet, directly analyzed. Not only does time naturally increase the mass of the products of chemical reaction; it also causes formations which would not otherwise exist. The chemical theory of time is at present a blank in science; and the phenomena of electro-chemistry seem likely to enlighten us on this head,—so all-important in its connection with chemical geology, while constituting an indispensable element in the conceptions of abstract chemistry.

To complete our survey of the philosophy of Chemistry, we must turn to some considerations already suggested, on the subject of what is commonly called Organic Chemistry.

CHAPTER V.

ORGANIC CHEMISTRY.

Confusion of two kinds of fact.

Organic Chemistry comprehends, it can not be denied, two kinds of researches, chemical and physiological, which are perfectly distinct. For instance, the study of organic acids, and especially the vegetable acids, and alcohol, ethers, etc., has a character as purely chemical as that of any inorganic substances whatever; and, on the other hand, there is no doubt of the biological character of inquiries into the composition of sap or blood, and of the analysis of the products of respiration, and many other matters included in organic chemistry. The confusion of the two orders is prejudicial to both sciences, and especially to physiology. The division of Chemistry conceals or violates essential analogies, and hinders the extension of dualism into the organic region, where it is seldom found, though, as I have shown, it is optional, in fact, throughout the whole range of chemistry; and thus the arbitrary arrangement is the chief obstacle in the way of the entire generalization of the doctrine of definite proportions. And whenever a true chemical theory shall fitly replace the antiphlogistic conception, it must necessarily comprehend all organic, as well as inorganic compounds. The most philosophical chemists are tending more and more to a recognition of the identity of the two departments; and there can be no doubt that the establishment of that identity will be an immediate consequence of a rational classification of chemical knowledge.

The confusion is more mischievous, but less felt by chemists, under the other view—the comprehension of biological phenomena among those of organic chemistry. The confusion arose from the need of chemical researches in very many physiological questions;

and these chemical researches, being usually extensive and difficult, were out of the range of the physiologists, and were taken possession of by the chemists, who annexed them to their own domain. Both classes were to blame for the vicious arrangement, and both must amend their scientific habits before a division can be effected in entire conformity to natural analogies. The physiologists have the most difficult task before them, having to qualify themselves for inquiries from which the chemists have only to abstain.

It is scarcely possible to characterize or to circumscribe the physiological part of organic chemistry, formed as it is by successive encroachments. It comprehends the chemical analysis of all the anatomical elements, solid or fluid, and that of the *products* of the organism; and if its usurpations remained unchecked, it would soon include the phenomena of what Bichat called the *organic life:* that is, the functions of nutrition and secretion, the only ones common to all living bodies, and in which the chemical point of view might well appear the natural one. In such a state of things, physiology would be reduced to the study of the functions of animal life, and to that of the development of the living being. It is easy to see what would become of biological science, if it were reduced to this fragmentary state. Chemists can not but be unfit for the rational examination of the important question of anatomy and physiology, vegetable and animal, because the research requires that comprehension of view which their studies, as chemists, preclude them from obtaining. In the anatomical relation, they are perpetually overlooking the fundamental division, established by M. de Blainville, between the true *elements* of the organism, and its simple *products;* and they take for one another, almost indifferently, the tissues, the parenchyma, and the organs. The spirit of biological investigation being unknown to them, they can neither choose their subject well, nor direct their analysis wisely. If these are grave inconveniences in anatomical questions, they are much more serious in physiological problems, properly so called, the essential conditions of which are not understood by chemists. The rational direction of physiological analysis can take place only by the subordination of the chemical to the physiological view; and therefore by the employment of chemistry by the physiologists themselves, as a simple means of investigation. It is an analogous case to that before exhibited, of the application of mathematical analysis to physical questions. If it is important that physicists should employ the instrument of analysis, instead of delivering over physical subjects to the mathematicians, to be a mere theme for analytical exercises, much more important is it that the greater diversity of view in chemistry and physiology should not be lost sight of. The irrational and incoherent studies comprised in the organic chemistry of our day give us no idea of the true nature of the aids that biology may derive from chemistry. A few instances will show the high importance of an improved organization of scientific labor.

Relation of Chemistry to Anatomy.

In the anatomical order, almost all the researches of chemists have to undergo an entire revision by the physiologists, before they can be applied to the studies of the elements or the products of the organism. The fine series of researches of M. Chevreul on fatty bodies are perhaps the only important chemical study immediately applicable to biology, animal or even vegetable. In the chemical analysis of blood or sap, or almost any other element, a single case, taken at hazard, is usually presented as a satisfactory type, without any comparative investigation either of each species of organism in its normal state, or of the degree of development of the living being—its sex, its temperament, its mode of alimentation, the system of its exterior conditions of existence, etc., and other modifications which physiologists alone can duly estimate. Such analyses correspond to nothing in anatomy but the single case observed; and even that is seldom sufficiently characterized. Hence inevitable divergences among chemists, who choose different types, and discussions of no scientific use, as the discordance is attributed to the different analytical methods employed, instead of to the variations which physiology would have led them to anticipate. The case is the same with regard to products first secreted and then excreted, as bile, saliva, etc., which offer a still greater complication. The chemists make no inquiry about the parts from which these products are taken, or the modifications which may have been occasioned by their remaining some time after their production, etc.; and therefore the analyses of these products, however often renewed, are still incoherent and thoroughly defective. We owe to M. Raspail a full exposure of the practice of the chemists of multiplying organic principles almost without limit, from differences of character which imply no distinction of nature, but are merely marks of various degrees of elaboration of the same principle in different developments of vegetation; and even from confounding the observed substances with their anatomical envelope. It is to be regretted that M. Raspail did not complete his great service to science by founding rationally the physiological portion of organic chemistry, instead of vainly attempting to systemize organic chemistry, under the bias of our crude chemical education.

To Physiology

If we turn from the anatomical order of questions to the physiological, we shall find yet stronger evidences of the inaptitude of chemists for biological inquiries. All endeavors have yet failed to establish any point of general doctrine in biology; and we find ourselves merely with simple materials, which must be newly elaborated by physiologists, under the view of vitality, before they can be put to use. To give an example or two:—the experiments of Priestley, Sennebier, Saussure, and others, on the mutual chemical action of vegetables and atmospheric air, were of the highest value, as instituting positive knowledge of the vegetable economy; but the inquiry is by no means so simple as its founders naturally supposed, after having analyzed one separate portion of the phenomenon of vegetation. The absorption of carbonic acid, and the exhalation of oxygen, though very important in relation to the action of leaves, are only one aspect of the double vital motion, and can not be understood but in the physiological view of both. This action can not explain the elementary composition of vegetable substances, or determine the kind of alteration sustained by the air through vegetation, because it is, in other ways, partially compensated by the precisely inverse action produced by the germination of seeds, the ripening of fruits, etc., and even, as regards the leaves, by the mere passage from light to darkness. It is much to have indicated the true nature of the requisite research, and to have supplied some materials for it. The rest is the business of the physiologist. If we turn to animal physiology for examples, the case is yet more striking.

After all the inquiry that has been made into the chemical phenomena of respiration, no fixed point is yet established. It was long supposed that the absorption by the lungs of atmospheric oxygen, and its transformation into carbonic acid, would explain the great phenomenon of the conversion of venous into arterial blood. But the problem is much more complicated than was supposed by the chemists who established this essential part of the phenomenon, and whose labors present the most contradictory conclusions in regard to the facts under their notice. We do not know, for instance, whether the quantity of carbonic acid formed really corresponds to the quantity of oxygen absorbed; and even the simple general difference between the inhaled and exhaled air, which is the first point to be ascertained, is far from being positively established. The atmospheric azote appears to some to be increased after respiration, while others say it is diminished, and others again that it remains the same. The disagreements about the changes in the composition of the blood are yet more marked. Perhaps the inaptitude of chemists and physicists for physiological researches is more striking still in the case of animal heat. In the early days of modern chemistry, this phenomenon seemed to be sufficiently accounted for by the disengagement of heat corresponding to the decarbonizing of the blood in the lungs, which the chemists regarded as the focus of a real combustion; but this explanation was soon found to be inadequate, even in a normal condition; and much more in various pathological cases. Uncertain as we still are as to the pulmonary influence in the process, we know that all the vital functions must concur in it, in a greater or smaller degree. There is even some reason to suppose, in direct opposition to the opinion of the chemists, that respiration, far from aiding to produce animal heat, constantly tends to diminish it. No doubt, the chemical effects occasioned by vital action must always be taken into the account in the study of animal heat; but it is only the physiologists who can deal with them in the light of the whole subject. When we have learned to combine the chemical and the physiological view, we may proceed to the formation of positive doctrine, without having to deal with preliminary obstacles; as, in regard to such questions as the general agreement between the chemical composition of living bodies, and that of the whole of their aliments; a case which constitutes one of the principal aspects of the vital state.

It is evident, at the outset, that every living body, whatever its origin, must be, in the long run, composed of the different chemical elements concerned in the substances, solid, liquid, and gaseous, by which it is habitually nourished; since, on the one hand, the vital motion subjects its parts to a continual renovation, and, on the other, we can not without absurdity suppose it capable of spontaneously producing any real element. This consideration is so far from involving any difficulty, that it might lead us to divine the general nature of the principal elements of living bodies; for animals feed in the first place on vegetable, or on other animals which have eaten vegetables; and in the second place, on air and water, which are the basis of the nutrition of plants: and thus, the organic world evidently admits of these chemical elements only which are furnished by the decomposition of air and water. When these two fluids have been duly analyzed, physiologists can, in a manner, foresee that animal and vegetable substances must be composed of oxygen, hydrogen, azote, and carbon, as chemistry taught them. It is true, such a prevision must be very imperfect, as it indicates nothing of the difference between animal and vegetable substances, nor why the latter usually contain so much carbon and so little azote. But this first glimpse, though it suggests some of the difficulty of the problem, yet indicates the possibility of establishing such a general harmony. But, when we proceed with the comparison, we encounter important objections, which are at present insoluble. The chief difficulty is that azote appears to be as abundant in the tissues of herbivorous as of carnivorous animals, though the solid aliments of the former contain scarcely any azote. The opinions of chemists, as of Berzelius and Raspail, as to the nature of azote, do not solve the difficulty, as they cast no light upon its origin. This is one of a multitude of cases in which we can not at all explain the chemical composition of anatomical elements by that of the exterior substances from which they are unquestionably derived. Another striking case is that of the constant presence of carbonate, and, yet more, phosphate of lime in the bony tissue, though the nature of the aggregate of aliments appears to afford no room for the formation of those salts. This system of investigations, considered in its whole range, constitutes one of the most important general questions that can arise from the chemical study of life; and if it is at present hardly initiated, the backwardness is owing, not only to its eminent difficulty, but to the biologists having abandoned to the chemists a task which, under a wise organization of labor, would have belonged to themselves alone.

Partition of Organic Chemistry.

In order to effect a rational division of organic chemistry, and to assign its portions to chemistry on the one hand and physiology on the other, we must take our stand on the separation between the state of life and that of death; or, what comes to nearly the same thing, between the stability and instability of the proposed combinations, submitted to the influence of common agents. Among the compounds indiscriminately called organic, some owe their existence only to vital motion; they exhibit perpetual variations, and usually constitute mere mixtures: and these can not belong to chemistry, but must enter into the domain of biology—statical or dynamical, according as we study their fixed condition, or the vital succession of their regular changes. Such, for instance, are blood, lymph, fat, etc. The others, which form the more immediate principles of these, are substances essentially dead, admitting of a remarkable permanence, and presenting all the characters of true combinations, independent of life: their natural place is, evidently, in the general system of chemical science, among the substances of inorganic origin, from which they differ in no important respect. Of these, the organic acids, alcohol, albumen, etc., are examples. These are the substances which truly belong to organic chemistry; and no reason exists for their separation from analogous inorganic substances, even if no injury was done by such an arbitrary division; and there is more reason for giving the title of *organic* to them than to the theory of oxygen, hydrogen, carbon, and azote, or to the study of many other substances, acid, alkaline, saline, etc., without which chemical anatomy and physiology would be unintelligible. As for chemical phenomena truly common to all compounds of this class, in consequence of the necessary identity of their chief elements, it is certainly important to assign to them their precise relations. The most important of these phenomena relate, at present, to the interesting and very imperfect theory of the different kinds of fermentation. But the consideration of these properties does not constitute a different order from that which results from the same ground in the case of many other compounds, purely inorganic. The property of fermentation, however important, has not a higher scientific value than that of burning, and has no more right to an exclusive classification. It is admitted that too much was attributed to combustion formerly, in regard to inorganic substances; and we may be attributing too much now to fermentation, or any other common property, among so-called organic bodies. We can not yet assign their proper place to these compounds in the rational system of chemical science; but we are able to affirm that, in that system, they must be more or less separated from each other, and interposed among substances called inorganic. Nothing more than this is needed to settle the question of the maintenance or the suppression of organic chemistry as a distinct body of doctrine. In applying the principle which I have proposed, to ascertain to which science any question belongs, it is enough to inquire whether chemical knowledge will serve the purposes of the research, or whether any biological considerations enter into it. The proposing such an alternative is, in fact, making the classification.

It is not our business to treat of any special application of this principle; but it is desirable to point out that in this partition of organic chemistry, its two portions are very unequally divided—the study of vegetable substances contributing most to chemistry, and that of animal substances to biology. At the first glance, we might suppose the difference to be the other way; for the importance of chemical considerations is really much greater with regard to living vegetables than animals, whose chemical functions are, except among the lowest orders of the zoological hierarchy, subordinated to a superior order of new vital actions. Yet, in virtue of the higher degree of vital elaboration that matter undergoes in the animal than in the vegetable organism, the chemical part of animal physiology presents a much greater extent and complexity than the vegetable, in which, for instance, the whole series of the phenomena of digestion is absent, and in which assimilation and secretion are much simplified. But, on account of the superior elaboration, and of the greater number of elements, animal substances are much less stable than vegetable: they rarely remain separate from the organism; and, at the same time, the new immediate principles proper to them are so few that their very existence has been questioned. Vegetation is evidently the chief source of true organic compounds, which are derived thence by the animal organism, and modified by it, either through their mutual combinations or new external influences. Thus, the true domain of chemical science must necessarily be more extended by the study of vegetable than by that of animal substances.

Enough has been said about the necessity of subjecting organic compounds to the law of dualism; but there is a particular aspect, under which the importance of this conception in improving chemical theories is worth a brief notice.

Application of dualism to organic compounds.

In considering substances as ternary or quaternary, their multiplicity is accounted for only by the difference in the proportions of their constituent elements—their component principles being identical. Very great differences are sometimes explained by inequalities of proportion so small as to shock the spirit of chemical analysis; and in other cases, the proportions being the same, the differences remain unaccounted for;—as, for instance, in the cases of sugar and gum, in which we find the same elements, combined in the same proportions. If we extend dualism to organic compounds, this class of anomalies disappears; for the distinction between immediate and elementary analysis enables us to resolve by dualism, in the most natural manner, the general paradox of the real diversity of two substances composed of the same elements, in the same proportions. In fact, these substances, identical in their elementary, would differ in the immediate analysis, as we may understand from what was offered in my chapter on the law of definite proportions. In another connection, chemists have remarked the possibility of exactly representing the numerical composition of alcohol or ether, etc., according to the several binary formulas, radically distinct from each other, and yet finally equivalent with regard to the elementary analysis. Now, if such fictitious combinations should ever be realized, they would produce highly distinct substances, which might differ much in the aggregate of their chemical properties, and yet coincide by their elementary composition. It is only necessary to transfer the same spirit into the study of organic combinations, by the establishment of a universal dualism, to dissipate all these anomalies: and the resource may thus be happily prepared, before the cases of isomerism (as Berzelius calls this fact) have become very numerous.

Summary of the chapter.

We have now seen how heterogeneous is the body of doctrine included under the name of organic chemistry; how it should be divided; what is the duty of physiologists with regard to their share of it; and how the extension of dualism will establish a natural agreement between the composition of substances and their collective characters.

Summary of the Book.

With regard to Chemistry at large, I have pointed out the true spirit of the science, under a philosophical view of its present aspects, and of the indispensable conditions of its advancement. We do not want new materials so much as the rational disposition of the details which already abound; and I have offered two prominent ideas, in my survey of chemical philosophy; the fusion of all genuinely chemical studies into one body of homogeneous doctrine; and the reduction of all combinations to the indispensable conception of a dualism always optional. These two conditions, distinct but connected, have been presented as necessary to the definitive constitution of chemical science. The application of such a conception to the only part of chemical research which yet exhibits anything of a positive rationality has removed all doubt about its general fitness, by showing its spontaneous aptitude to resolve the anomalies of numerical chemistry.

With this division closes our survey of the whole of natural philosophy that relates to universal or inorganic phenomena. In the order of phenomena to which we next proceed, there is at once much more complexity, and much less established order. The study of them is scarcely yet organized; and yet, out of the speciality of the phenomena arises the most indispensable part of natural philosophy—that of which Man is first the chief object, and then Society.

BOOK V.

BIOLOGY

CHAPTER I.

GENERAL VIEW OF BIOLOGY.

Opposite starting-points in philosophy.

THE study of the external world and of Man is the eternal business of philosophy; and there are two methods of proceeding; by passing from the study of man to that of external nature, or from the study of external nature to that of man. Whenever philosophy shall be perfect, the two methods will be reconciled: meantime, the contrast of the two distinguishes the opposite philosophies—the theological and the positive. We shall see hereafter that all theological and metaphysical philosophy proceeds to explain the phenomena of the external world from the starting-point of our consciousness of human phenomena; whereas, the positive philosophy subordinates the conception of man to that of the external world. All the multitude of incompatibilities between the two philosophies proceed from this radical opposition. If the consideration of man is to prevail over that of the universe, all phenomena are inevitably attributed to *will*—first natural, and then outside of nature; and this constitutes the theological system. On the contrary, the direct study of the universe suggests and develops the great idea of the *laws* of nature, which is the basis of all positive philosophy, and capable of extension to the whole of phenomena, including at last those of Man and Society. The one point of agreement among all schools of theology and metaphysics, which otherwise differ without limit, is that they regard the study of man as primary, and that of the universe as secondary—usually neglecting the latter entirely. Whereas, the most marked characteristic of the positive school is that it founds the study of man on the prior knowledge of the external world.

Starting-point of Physiology.

This consideration affects physiology further than by its bearing on its encyclopedical rank. In this one case the character of the science is affected by it. The basis of its positivity is its subordination to the knowledge of the external world.

Any multitude of facts, however well analyzed, is useless as long as the old method of philosophizing is persisted in, and physiology is conceived of as a direct study, isolated from that of inert nature. The study has assumed a scientific character only since the recent period when vital phenomena began to be regarded as subject to general laws, of which they exhibit only simple modifications. This revolution is now irreversible, however incomplete and however imperfect have been the attempts to establish the positive character of our knowledge of the most complex and individual of physiological phenomena; especially that of the nerves and brain. Yet, unquestionable as is the basis of the science, its culture is at present too like that to which men have been always accustomed, pursued independently of mathematical and inorganic philosophy, which are the only solid foundations of the positivity of vital studies.

There is no science with regard to which it is so necessary to ascertain its true nature and scope; because we have not only to assign its place in the scale, but to assert its originality. On the one hand, metaphysics strives to retain it; and on the other, the inorganic philosophy lays hold of it, to make it a mere outlying portion of its scientific domain. For more than a century, during which biology has endeavored to take its place in the hierarchy of fundamental sciences, it has been bandied between metaphysics and physics; and the strife can be ended only by the decision of positive philosophy, as to what position shall be occupied by the study of living bodies.

Its present imperfection.

The present backwardness of the science is explained by the extreme complexity of its phenomena, and its recent date. That complexity forbids the hope that biological science can ever attain a perfection comparable to that of the more simple and general parts of natural philosophy; and, from its recent date, minds which see in every other province the folly of looking for first causes and modes of production of phenomena, still carry these notions into the study of living bodies. For more than a century, intelligent students have in physics put aside the search after the mystery of weight, and have looked only for its laws; yet they reproach physiology with teaching us nothing of the nature of life, consciousness, and thought. It is easy to see how physiology may thus be supposed to be far more imperfect than it is; and if it be, from unavoidable circumstances, more backward than the other fundamental sciences, it yet includes some infinitely valuable conceptions, and its scientific character is far less inferior than is commonly supposed.

We must first describe its domain.

Its field.

There is no doubt that the gradual development of human intelligence would, in course of time, lead us over from the theological and metaphysical state to the positive by a series of logical conceptions. But such an advance would be extremely slow; and we see, in fact, that the process is much quickened by a special stimulus of one sort or another. Our historical experience, which testifies to every great advance having been made in this way, shows that the most common auxiliary influence is the need of application of the science in question. Most philosophers have said that every science springs from a corresponding art:—a maxim which, amid much exaggeration, contains solid truth, if we restrict it, as we ought, to the separation of each science from the theological and metaphysical philosophy which was the natural product of early human intelligence. In this view, it is true that a double action has led to the institution of science, the arts furnishing positive data, and then leading speculative researches in the direction of real and accessible questions. But there is another side to this view. When the science has once reached a certain degree of extension, the progress of speculative knowledge is checked by a too close connection of theory with practice. Our power of speculation, limited as it is, still far surpasses our capacity for action: so that it would be radically absurd to restrict the progress of the one to that of the other. The rational domains of science and art are, in general, perfectly distinct, though philosophically connected: in the one we learn to know, and therefore to foreknow; in the other to become capable, and therefore to act. If science springs from art, it can be matured only when it has left art behind. This is palpably true with regard to the sciences whose character is clearly recognised. Archimedes was, no doubt, deeply aware of it when he apologized to posterity for having for the moment applied his genius to practical inventions. In the case of mathematics and astronomy we have almost lost sight of this truth, from the remoteness of their formation; but in the case of physics and chemistry, at whose scientific birth we may almost be said to have been present, we can ourselves testify to their dependence on the arts at the outset, and to the rapidity of their progress after their separation from them. The first series of chemical facts were furnished by the labors of art; but the prodigious recent development of the science is certainly due, for the most part, to the speculative character that it has assumed.

Relation to Medicine.

These considerations are eminently applicable to physiology. No other science has been as closely connected with a corresponding art, as biology has with medical art,—a fact accounted for by the high importance of the art and the complexity of the science. But for the growing needs of practical medicine, and the indications it affords about the chief vital phenomena, physiology would have probably stopped short at those academical dissertations, half literary, half metaphysical, studded with episodical adornments, which constituted what was called the science little more than a century ago. The time, however, has arrived when biology must, like the other sciences, make a fresh start in a purely speculative direction, free from all entanglement with medical or any other art. And when this science and the others shall have attained an abstract completeness, then will arise the further duty, as I have indicated before, of connecting the system of the arts with that of the sciences by an intermediate order of rational conceptions. Meanwhile such an operation would be premature, because the system of the sciences is not completely formed; and, with regard to physiology especially, the first necessity is to separate it from medicine, in order to secure the originality of its scientific character, by constituting organic science as a consequence of inorganic. Since the time of Haller, this process has gone on; but with extreme uncertainty and imperfection; so that even now the science is, with a few valuable exceptions, committed to physicians, who are rendered unfit for such a charge both by the eminent importance of their proper business, and by the profound imperfection of their existing education. Physiology is the only science which is not taken possession of by minds exclusively devoted to it. It has not even a regularly-assigned place in the best-instituted scientific corporations. This state of things can not last, the importance and difficulty of the science being considered. If we would not confide the study of astronomy to navigators, we shall not leave physiology to the leisure of physicians. Such an organization as this is a sufficient evidence of the prevalent confusion of ideas about physiological science; and when its pursuit has been duly provided for, that reaction for the benefit of art will ensue which should put to flight all the fears of the timid about the separation of theory from practice. We have seen before how the loftiest truths of science concur to put us in possession of an art; and the verification of this truth, which physics and chemistry have afforded before our eyes, will be repeated in the case of physiology when the science has advanced as far.

Its object.

Having provided for a speculative view of physiology, we must inquire into its object; and, as the vital laws constitute the essential subject of biology, we must begin by analyzing the fundamental idea of *life*.

Idea of Life.

Before the time of Bichat, this idea was wrapped in a mist of metaphysical abstractions; and Bichat himself, after having perceived that a definition of life could be founded on nothing else than a general view of phenomena proper to living bodies, so far fell under the influence of the old philosophy as to call life a struggle between dead nature and living nature. The irrationality of this conception consists especially in its suppressing one of the two elements whose concurrence is necessary to the general idea of *life*. This idea supposes, not only a being so organized as to admit of the vital state, but such an arrangement of external influences as will also admit of it. The harmony between the living being and the corresponding *medium* (as I shall call its environment) evidently characterizes the fundamental condition of life; whereas, on Bichat's supposition, the whole environment of living beings tends to destroy them. If certain perturbations of the medium occasionally destroy life, its influence is, on the whole, preservative; and the causes of injury and death proceed at least as often from necessary and spontaneous modifications of the organism as from external influences. Moreover, one of the main distinctions between the organic and the inorganic regions is that inorganic phenomena. from their greater simplicity and generality, are produced under almost any external influences which admit of their existence at all; while organic bodies are, from their complexity, and the variety of actions always proceeding, very closely dependent on the influences around them. And the higher we ascend in the ranks of organic bodies, the closer is this dependence, in proportion to the diversity of functions; though, as we must bear in mind, the power of the organism in modifying the influences of the medium rises in proportion. The existence of the being then requires a more complex aggregate of exterior circumstances; but it is compatible with wider limits of variation in each influence taken by itself. In the lowest rank of the organic hierarchy, for instance, we find vegetables and fixed animals which have no effect on the medium in which they exist, and which would therefore perish by the slightest changes in it, but for the very small number of distinct exterior actions required by their life. At the other extremity we find Man, who can live only by the concurrence of the most complex exterior conditions, atmospherical and terrestrial, under various physical and chemical aspects; but, by an indispensable compensation, he can endure, in all these conditions, much wider differences than inferior organisms could support, because he has a superior power of reacting on the surrounding system. However great this power, it is as contradictory to Bichat's view as his dependence on the exterior world. But this notion of Man's independence of exterior nature, and antagonism to it, was natural in Bichat's case, when physiological considerations bore no relation to any hierarchy of organisms, and when Man was studied as an isolated existence. However, the radical vice of such a starting-point for such a study could not but impair the whole system of Bichat's physiological conceptions; and we shall see how seriously the effects have made themselves felt.

Next ensued the abuse, by philosophers, and especially in Germany, of the benefits disclosed by comparative anatomy. They generalized extravagantly the abstract notion of life yielded by the study of the aggregate of organized beings, making the idea of life exactly equivalent to that of spontaneous activity. As all natural bodies are active, in some manner and degree, no distinct notion could be attached to the term; and this abuse must evidently lead us back to the ancient confusion, which arose from attributing life to all bodies. The inconvenience of having two terms to indicate a single general idea should teach us that, to prevent scientific questions from degenerating into a contest of words, we must carefully restrict the term *life* to the only really living beings,—that is, those which are organized,—and not give it a meaning which would include all possible organisms, and all their modes of vitality. In this case, as in all primitive questions, the philosophers would have done wisely to respect the rough but judicious indications of popular good sense, which will ever be the true starting-point of all wise scientific speculation.

De Blainville's definition.

I know of no other successful attempt to define life than that of M. de Blainville, proposed in the introduction to his treatise on Comparative Anatomy. He characterizes life as the double interior motion, general and continuous, of composition and decomposition, which in fact constitutes its true universal nature. I do not see that this leaves anything to be desired, unless it be a more direct and explict indication of the two correlative conditions of a determinate organism and a suitable medium. This criticism however applies rather to the formula than to the conception; and the conditions are implied in the conception,—the conditions of an organism to sustain the renovation, and a medium to minister to the absorption and exhalation; yet it might have been better to express them. With this modification, the definition is unexceptionable,—enunciating the one phenomenon which is common to all living beings, and excluding all inert bodies. Here we have, in my view, the first elementary basis of true biological philosophy.

It is true, this definition neglects the eminent distinction between the *organic* and the *animal* life, and relates solely to the vegetative life; and it appears to violate the general principle of definitions,—that they should exhibit a phenomenon in the case in which it is most, and not in that in which it is least developed. But the proposed definition is shown, by these very objections, to rest upon a due estimate of the whole biological hierarchy: for the animal life is simply a complementary advancement upon the organic or fundamental life, adapted to procure materials for it by reaction upon the external world, and to prepare or facilitate its acts by sensations, locomotion, etc., and to preserve it from unfavorable influences. The higher animals, and Man especially, are the only ones in which this relation is totally subverted,—the vegetative life being destined to support the animal, which is erected into the chief end and preponderant character of organic existence. But in Man himself, this admirable inversion of the usual order becomes comprehensible only by the aid of remarkable development of intelligence and sociality, which tends more and more to transform the species artificially into a single individual, immense and eternal, endowed with a constantly progressive action upon external nature. This is the only just view to take of this subordination of the vegetative to the animal life, as the ideal type toward which civilized humanity incessantly tends, though it can never be fully realized. We shall hereafter show how this conception is related to the new fundamental science which I propose to constitute: but in pure biology, the view is unscientific, and can only lead us astray. It is not with the essential properties of humanity that biology is concerned; but with the individual in his relation to other organic beings; and it must therefore rigorously maintain the conception of animal life being subordinated to the vegetative, as a general law of the organic realm, and the only apparent exception to which forms the special object of a wholly different fundamental science. It should be added that, even where the animal life is the most developed, the organic life, besides being the basis and the end, remains common to all the tissues, while, at the same time, it alone proceeds in a necessarily continuous manner,—the animal life, on the contrary, being intermittent. These are the grounds on which M. de Blainville's definition of life must be confirmed, while, nevertheless, we may regard the consideration of animality, and even of humanity, as the most important object of biology.

Definition of Biology.

This analysis of the phenomenon of life will help us to a clear definition of the science which relates to it. We have seen that the idea of life supposes the mutual relation of two indispensable elements,—an organism, and a suitable medium or environment. It is from the reciprocal action of these two elements that all the vital phenomena proceed;—not only the animal, but also the organic. It immediately follows that the great problem of positive biology consists in establishing, in the most general and simple manner, a scientific harmony between these two inseparable powers of the vital conflict, and the act which constitutes that conflict: in a word, in connecting, in both a general and special manner, the double idea of organ and medium with that of function. The idea of function is, in fact, as double as the other; and, if we were treating of the natural history of vital beings, we must expressly consider it so: for, by the law of the equivalence of action and reaction, the organism must act on the medium as much as the medium on the organism. In treating of the human being, and especially in the social state, it would be necessary to use the term *function* in this larger sense: but at present there will be little inconvenience in adopting it in its ordinary sense, signifying organic acts, independently of their exterior consequences.

Biology, then, may be regarded as having for its object the connecting, in each determinate case, the anatomical and the physiological point of view; or, in other words, the statical and dynamical. This perpetual relation constitutes its true philosophical character. Placed in a given system of exterior circumstances, a definite organism must always act in a necessarily determinate manner; and, inversely, the same action could not be precisely produced by really distinct organisms. We may then conclude interchangeably, the act from the subject, or the agent from the act. The surrounding system being always supposed to be known, according to the other fundamental sciences, the double biological problem may be laid down thus, in the most mathematical form, and in general terms: *Given, the organ or organic modification, to find the function or the act, and reciprocally.* This definition seems to me to fulfil the chief philosophical conditions of the science; and especially it provides for that rational prevision, which, as has been so often said, is the end of all true science; an end which abides through all the degrees of imperfection which, in any science, at present prevents its attainment. It is eminently important to keep this end in view in a science so intricate as this, in which the multitude of details tempts to a fatal dispersion of efforts upon desultory researches. No one disputes that the most perfect portions of the science are those in which prevision has been best realized; and this is a sufficient justification of the proposal of this aim, whether or not it shall ever be fully attained. My definition excludes the old division between anatomy and physiology, because I believe that division to have marked a very early stage of the science, and to be no longer sustainable. It was by the simple and easy considerations of anatomy that the old metaphysical view was discredited, and positivity first introduced into biology: but that service once accomplished, no reason remains for the separation; and the division, in fact, is growing fainter every day.

Not only does my definition abstain from separating anatomy from physiology; it joins to it another essential part, the nature of which little is known. If the idea of life is really inseparable from that of organization, neither can be severed, as we have seen, from that of a medium or environment, in a determinate relation with them. Hence arises a third elementary aspect; viz., the general theory of organic media, and of their action upon the organism, abstractedly regarded. That is what the German philosophers of our day confusedly asserted in their notion of an intermediate realm—of air and water—uniting the inorganic and organic worlds: and this is what M. de Blainville had in view in what he called the study of exterior modifiers, general and special. Unhappily, this portion which, after anatomy proper, is the most indispensable preliminary of biology, is still so obscure and imperfect that few physiologists even suspect its existence.

The definition that I have proposed aids us in describing not only the object or nature of the science, but its subject, or domain; for, according to this formula, it is not in a single organism, but in all known, and even possible organisms, that biology must endeavor to establish a constant and necessary harmony between the anatomical point of view and the physiological. This unity of subject is one of the chief philosophical beauties of biology; and, in order to maintain it, we must here avow that, in the midst of an almost infinite diversity, the study of man must always prevail, and rule all the rest, whether as starting-point or aim. Our hope, in studying other organisms, is to arrive at a more exact knowledge of man: and again, the idea of man is the only possible standard to which we can refer other organic systems. In this sense, and in this only, can the point of view of the antiquated philosophy be sustained by the deeper philosophy which is taking its place. Such is, then, the necessary consolidation of all the parts of biological science, notwithstanding the imposing vastness of its rational domain.

Means of investigation.

As for the means of investigation in this science—the first observation that occurs is that it affords a striking confirmation of the philosophical law before laid down, of the inevitable increase of our scientific resources in proportion to the complication of the phenomena in question. If biological phenomena are incomparably more complex than those of any preceding science, the study of them admits of the most extensive assemblage of intellectual means (many of them new) and develops human faculties hitherto inactive, or known only in a rudimentary state. The logical resources which are thus obtained will be exhibited hereafter. At present, we must notice the means of direct exploration and analysis of phenomena in this science.

OBSERVATION.

First, observation acquires a new extension. Chemistry admitted the use of all the five senses; but biology is, in this respect, an advance upon chemistry. We can here employ an artificial apparatus to perfect the natural sensations, and especially in the case of sight. Much needing precaution in the use, and very subject to abuse, as is this resource, it will always be eagerly employed. In a statical view, such an apparatus helps us to a much better estimate of a structure whose least perceptible details may acquire a primary importance, in various relations: and, even in the dynamical view, though much less favorable, we are sometimes enabled by these artificial means to observe directly the elementary play of the smallest organic parts, which are the ordinary basis of the principal vital phenomena. Till recently, these aids were limited to the sense of sight, which here, as everywhere else, is the chief agent of scientific observation. But some instruments have been devised in our day to assist the hearing; and, though invented for pathological investigations, they are equally fit for the study of the healthy organism. Though rough at present, and not to be compared to microscopic apparatus, these instruments indicate the improvements that may be made hereafter in artificial hearing. Moreover, they suggest, by analogy, that the other senses, not excepting even touch, may admit of such assistance, hinted to the restless sagacity of explorers by a better theory of the corresponding sensations.

Artificial apparatus.

Chemical exploration.

Next, the biologist has an advantage over the chemist in being able to employ the whole of chemical procedures, as a sort of new power, to perfect the preliminary exploration of the subject of his researches, according to the evident rule of philosophy that each doctrine may be converted into a method with regard to those that follow it in the scientific hierarchy; but never with regard to those which precede it. In anatomical observations, especially, as might be foreseen, a happy use is made of chemical procedure, to characterize with precision the different elementary tissues, and the chief products of the organism. In physiological observations, also, though they are less favorable to the use of such means, they are of real and notable efficacy—always supposing, in both cases, that they are used under the guidance of sound philosophy, and not overcharged with the minute numerical details which too often burden the chemical analysis of the organic tissues. One more resource may be mentioned, which was often employed by Bichat to make up for the absence or imperfection of chemical tests; the examination of alimentary effects—the substances which immediately compose organized bodies being, usually, by their nature, more or less fit for nutrition. In an anatomical view, this study may become a useful complement of the other means of investigation.

EXPERIMENT.

Proceeding to the second class of means—Experiment can not but be less and less decisive, in proportion to the complexity of the phenomena to be explored: and therefore we saw this resource to be less effectual in chemistry than in physics; and we now find that it is eminently useful in chemistry in comparison with physiology. In fact, the nature of the phenomena seems to offer almost insurmountable impediments to any extensive and prolific application of such a procedure in biology. These phenomena require the concurrence of so large a number of distinct influences, external and internal, which, however diverse, are closely connected with each other, and yet within narrow limits, that, however easy it may be to disturb or suspend the process under notice, it is beyond measure difficult to effect a determinate perturbation. If too powerful, it would obviate the phenomenon: if too feeble, it would not sufficiently mark the artificial case. And, on the other hand, though intended and directed to modify one only of the phenomena, it must presently affect several others, in virtue of their mutual sympathy. Thus, it requires a highly philosophical spirit, acting with extreme circumspection, to conduct physiological experiments at all; and it is no wonder if such experiments have, with a few happy exceptions, raised scientific difficulties greater than those proposed to be solved—to say nothing of those innumerable experiments which, having no definite aim, have merely encumered the science with idle and unconnected details.

In accordance with what has been said of the mutual relations of the organism and its environment, we must bear in mind that experiments in physiology must be of two kinds. We must introduce determinate perturbations into the medium as well as the organism; whereas the latter process has alone been commonly attempted. If it is objected that the organism must itself be disturbed by such affection of the medium, the answer is that the study of this reaction is itself a part of the experiment. It should be remarked that experimentation on the organism is much the less rational of the two methods, because the conditions of experiment are much less easily fulfilled. The first rule, that the change introduced shall be fully compatible with the existence of the phenomenon to be observed, is rendered often impracticable by the incompatibility of life with much alteration of the organs; and the second rule—that the two compared cases

By affecting the organism.

shall differ under only one point of view—is baffled by the mutual sympathy of the organs, which is very different from their harmony with their environment. In both lights, nothing can be imagined more futile in the way of experiment than the practice of vivisection, which is the commonest of all. Setting aside the consideration of the cruelty, the levity, and the bad moral stimulus involved in the case, it must be pronounced absurd; for any positive solution is rendered impossible by the induced death of a system eminently indivisible, and the universal disturbance of the organism under its approach.

By affecting the Medium.

The second class of physiological experiments appears to me much more promising; that in which the system of exterior circumstances is modified for a determinate purpose. Scarcely anything has been done in this direction beyond some incomplete researches into the action of artificial atmospheres, and the comparative influence of different kinds of alimentation. We are here better able to circumscribe, with scientific precision, the artificial perturbation we produce; we can control the action upon the organism, so that the general disturbance of the system may affect the observation very slightly; and we can suspend the process at pleasure, so as to allow the restoration of the normal state before the organism has undergone any irreparable change. It is easy to see how favorable, in comparison, these conditions are to rational induction. And to these considerations may be added the one more, that under this method we can observe varying states in one individual; whereas, under the practice of vivisection, we have to observe the normal state in one individual, and the artificial in another. Thus we are justified in our satisfaction that the least violent method of experimentation is the most instructive.

Comparative experiment.

As to the application of experiment in the various degrees of the biological scale;—it is easiest in the lower order of organisms, because their organs are simpler and fewer, their mutual sympathy is less, and their environment is more definite and less complex; and these advantages, in my opinion, more than compensate for the restriction of the field of experiment. It is true, we are remote from the human type, which is the fundamental unity of biology; and our judgment is thus impaired, especially with regard to the phenomena of animal life: but, on the other hand, we are all the nearer to the scientific constitution proper to inorganic physics, which I consider to be the ultimate destination of the art of experiment. The advantages at the other end of the scale are that the higher the organism, the more is it susceptible of modification, both from its own complexity and from the greater variety of external influences involved;—every advantage bringing with it, as we have seen, an increase of difficulty.

No one will suppose, I trust, that from anything I have said I have the slightest desire to undervalue the use of experiment in biology, or to slight such achievements as Harvey's experiments on circulation; Haller's on irritability; part of Spallanzani's on digestion and generation; Bichat's on the triple harmony between the heart, the brain, and the lungs in the superior animals; those of Legallois on animal heat; and many analogous efforts which, seeing the vast difficulty of the subject, may rival the most perfect investigations in physics. My object is simply to rectify the false or exaggerated notions of the capacity of the experimental method, misled by its apparent facility to suppose it the best method of physiological research; which it is not. One consideration remains in this connection; the consideration of the high scientific destination of pathological investigation, regarded as offering, in biology, the real equivalent of experimentation, properly so called.

Pathological Investigation.

Precisely in the case in which artificial experimentation is the most difficult, nature fulfils the conditions for us; and it would surely be mistaking the means for the end to insist on introducing into the organism perturbations of our own devising, when we may find them taking place without that additional confusion which is caused by the use of artificial methods. Physiological phenomena lend themselves remarkably to that spontaneous experimentation which results from a comparison of the normal and abnormal states of the organism. The state of disease is not a radically different condition from that of health. The pathological condition is to the physiological simply a prolongation of the limits of variation, higher or lower, proper to each phenomenon of the normal organism; and it can never produce any entirely new phenomenon. Therefore, the accurate idea of the physiological state is the indispensable ground of any sound pathological theory; and therefore, again, must the scientific study of pathological phenomena be the best way to perfect our investigations into the normal state. The gradual invasion of a malady, and the slow passage from an almost natural condition to one of fully-marked disease, are far from being useless preliminaries, got rid of by the abrupt introduction of what may be called the violent malady of direct experiment: they offer, on the contrary, inestimable materials to the biologist able to put them to use. And so it is also in the happy converse case, of the return, spontaneous or contrived, to health, which presents a sort of verification of the primitive analysis. Moreover, the direct examination of the chief phenomenon is not obscured, but much elucidated, by this natural process. And again, it may be applied directly to Man himself, without prejudice to the pathology of animals, and even of vegetables. We may enjoy our power of turning our disasters to the profit of our race: and we can not but deplore the misfortune that our great medical establishments are so constituted as that little rational instruction is obtained from them, for want of complete observations and duly-prepared observers.

Here, as elsewhere, the distinction holds of the phenomena belonging to the organism or to the medium; and here, as before, we find the maladies produced from without the most accessible to inquiry. Pathological inquiry is also more suitable than experimental, to the whole biological series: and thus it answers well to extend our observations through the entire hierarchy, though our object may be the study of Man; for his maladies may receive much light from a sound analysis of the derangements of other organisms,—even the vegetable, as we shall see when we treat of the comparative process.

Again, pathological analysis is applicable, not only to all organisms, but to all phenomena of the same organism; whereas direct experimentation is too disturbing and too abrupt to be ever applied with success to certain phenomena which require the most delicate harmony of a varied system of conditions. For instance, the observation of the numerous maladies of the nervous system offers us a special and inestimable means of improving our knowledge of the laws of intellectual and moral phenomena, imperfect as are yet our qualifications for using them. There remains one other means of knowledge under this head; the examination of exceptional organizations, or cases of monstrosity. As might be anticipated, these organic anomalies were the last to pass over from the gaze of a barren curiosity to the investigation of science; but we are now learning to refer them to the laws of the regular organism, and to subject them to pathological procedures, regarding such exceptions as true maladies, of a deeper and more obscure origin than others, and of a more incurable nature;—considerations which, of course, reduce their scientific value. This resource shares with pathology the advantage of being applicable through the whole range of the biological system.

It is still necessary to insist that, in either method of experimentation, direct or indirect, artificial or natural, the elementary rules should be kept in view; first, to have a determinate aim, that is, to seek to illustrate an organic phenomenon, under a special aspect; and, secondly, to understand beforehand the normal state, and its limits of variation. In regard to the more advanced sciences, it would seem puerile to recommend such maxims as these; but we must still insist on them in biology. It is through neglect of them that all the observations yet collected on the derangements of the intellectual and moral phenomena have yielded scarcely any knowledge of their laws. Thus, whatever may be the value of the most suitable method of experimentation, we must ever remember that here, as elsewhere, and more than elsewhere, pure observation must always hold the first rank, as casting light, primarily, on the whole subject, which it is proposed to examine afterward, as a special study, with a determinate view, by the method of experimentation.

COMPARISON.

In the third place, we have to review the method of Comparison, which is so specially adapted to the study of living bodies, and by which, above all others, that study must be advanced. In Astronomy, this method is necessarily inapplicable: and it is not till we arrive at Chemistry that this third means of investigation can be used; and then, only in subordination to the two others. It is in the study, both statical and dynamical, of living bodies, that it first acquires its full development; and its use elsewhere can be only through its application here.

The fundamental condition of its use is the unity of the principal subject, in combination with a great diversity of actual modifications. According to the definition of life, this combination is eminently realized in the study of biological phenomena, however regarded. The whole system of biological science is derived, as we have seen, from one great philosophical conception; the necessary correspondence between the ideas of organization and those of life. There can not be a more perfect fundamental unity of subject than this; and it is unnecessary to insist upon the almost indefinite variety of its modifications,—statical and dynamical. In a purely anatomical view, all possible organisms, all the parts of each organism, and all the different states of each, necessarily present a common basis of structure and of composition, whence proceed successively the different secondary organizations which constitute tissues, organs, and systems of organs, more or less complicated. In the same way, in a physiological view, all living beings, from vegetable to man, considered in all the acts and periods of their existence, are endowed with a certain common vitality, which is a necessary basis of the innumerable phenomena which characterize them in their degrees. Both these aspects present as most important, and really fundamental, what there is in common among all the cases; and their particularities as of less consequence; which is in accordance with the great prevalent law, that the more general phenomena overrule the less. Thus broad and sound is the basis of the comparative method, in regard to biology.

At the first glance the immensity of the science is overwhelming to the understanding, embracing as it does all organic and vital cases, which it appears impossible ever to reduce within the compass of our knowledge: and no doubt, the discouragement hence arising is one cause of the backwardness of biological philosophy. Yet the truth is that this very magnitude affords not an obstacle, but a facility to the perfecting of the science, by means of the luminous comparison which results from it, when once the human mind becomes familiar enough with the conditions of the study to dispose its materials so as to illustrate each other. The science could make no real progress while Man was studied as an isolated subject. Man must necessarily be the type; because he is the most complete epitome of the whole range of cases: Man, in his adult and normal state, is the representative of the great scientific unity, whence the successive terms of the great biological series recede, till they terminate in the simplest organizations, and the most imperfect modes of existence. But the science would remain in the most defective state in regard to Man himself, if it were not pursued through a perpetual comparison, under all possible aspects, of the first term with all inferior ones, till the simplest was reached: and then, back again, through the successive complications which occur between the lowest type and the highest. This is the most general, the most certain, the most effectual method of studying physiological as well as anatomical phenomena. Not only is there thus a greater number of cases known, but each case is much better understood by their approximation. This would not be the case, and the problem would be embarrassed instead of simplified, if there were not a fundamental resemblance among the whole series, accompanied by gradual modifications, always regulated in their course: and this is the reason why the comparative method is appropriate to biology alone, of all the sciences, except, as we shall see hereafter, in social physics.

Complete and spontaneous as this harmony really is, no philosopher can contemplate without admiration the eminent art by which the human mind has been aided to convert into a potent means what appeared at first to be a formidable difficulty. I know no stronger evidence of the force of human reason than such a transformation affords. And in this case, as in every other in which primordial scientific powers are concerned, it is the work of the whole race, gradually developed in the course of ages, and not the original product of any isolated mind—however some moderns may be asserted to be the creators of comparative biology. Between the primitive use that Aristotle made of this method in the easiest cases —as in comparing the structure of Man's upper and lower limbs—to the most profound and abstract approximations of existing biology, we find a very extensive series of intermediate states, constantly progressive among which history can point out individually only labors which prove what had been the advance in the spirit of the comparative art at the corresponding period, as manifested by its larger and more effectual application. It is evident that the comparative method of biologists was no more the invention of an individual than the experimental method of the physicists.

Five kinds of comparison.

There are five principal heads under which biological comparisons are to be classed.

1. Comparison between the different parts of the same organism.
2. Comparison between sexes.
3. Comparison between the various phases presented by the whole of the development.
4. Comparison between the different races or varieties of each species.
5. Lastly, and pre-eminently, Comparison between all the organisms of the biological hierarchy.

It must be understood that the organism is always to be supposed in a normal state. When the laws of that state are fully established, we may pass on to pathological comparison, which will extend the scope of those laws: but we are not yet advanced enough in our knowledge of normal conditions to undertake anything beyond. Moreover, though comparative pathology would be a necessary application of biological science, it can not form a part of that science, but rather belongs to the future medical science, of which it must form the basis.—Again, biological comparison can take place only between the organisms, and not between them and their medium. When such comparison comes to be instituted, it will be, not as biological science, but as a matter of natural history.

The spirit of biological comparison is the same under all forms. It consists in regarding all cases as radically analogous in respect to the proposed investigation, and in representing their differences as simple modifications of an abstract type; so that secondary differences may be connected with the primary according to uniform laws; these laws constituting the biological philosophy by which each determinate case is to be explained. If the question is anatomical, Man, in his adult and normal state, is taken for the fundamental unity, and all other organizations as successive simplifications, descending from the primitive type, whose essential features will be found in the remotest cases, stripped of all complication. If the question is physiological, we seek the fundamental identity of the chief phenomenon which characterizes the function proposed, amid the graduated modifications of the series of comparative cases, till we find it isolated, or nearly so, in the simplest case of all; and thence we may trace it back again, clothed in successive complications of secondary qualities. Thus the theory of analogous existences, which has been offered as a recent innovation, is only the necessary principle of the comparative method, under a new name. It is evident that this method must be of surpassing value when philosophically applied: and also that, delicate as it is, and requiring extreme discrimination and care in its estimate and use, it may be easily converted into a hinderance and embarrassment, by giving occasion to vicious speculations on analogies which are only apparent.

Of the five classes specified above, three only are so marked as to require a notice here: the comparison between the different parts of the same organism; between the different phases of each development; and between the distinct terms of the great hierarchy of living bodies.

Comparison of parts of the same organism.

The method of comparison began with the first of these. Looking no further than Man, no philosophical mind can help being struck by the remarkable resemblance that his different chief parts bear to each other in many respects,—both as to structure and function. First, all the tissues, all the apparatus, in as far as they are organized and living, offer those fundamental characteristics which are inherent in the very ideas of organization and life, and to which the lowest organisms are reduced. But, in a more special view, the analogy of the organs becomes more and more marked as that of the functions is so; and the converse; and this often leads to luminous comparisons, anatomical and physiological, passing from the one to the other, alternately. This original and simple method of comparison is by no means driven out by newer processes. It was thus, for instance, that Bichat, whose subject was Man only, and adult Man, discovered the fundamental analogy between the mucous and the cutaneous systems, which has yielded so much advantage to both biology and pathology. And again, with all M. de Blainville's mastery of the principle of the comparative method, we can not doubt the sufficiency of the analysis of the human organism to establish the resemblance he exhibited between the skull and the other elements of the vertebral column.

Of phases of the same organism.

A new order of resources presents itself when we compare the different phases of the same organism. Its chief value is in its offering, on a small scale, and, as it were, under one aspect, the whole series of the most marked organisms of the biological hierarchy; for it is obvious that the primitive state of the highest organism must present the essential characters of the complete state of the lowest; and thus successively,—without, however, compelling us to find the counterpart of every inferior term in the superior organism. Such an analysis of ages unquestionably offers the property of realizing in an individual, that successive complication of organs and functions which characterizes the biological hierarchy, and which, in this homogeneous and compact form, constitutes a special and singular order of luminous comparisons. Useful through all degrees of the scale, it is evidently most so in the case of the highest type, the adult Man, as the interval from the origin to the utmost complexity is in that case the greatest. It is valuable chiefly in the visible ascendant period of life; for we know very little of the fœtal period; and the declining stage, which is in fact only a gradual death, presents little scientific interest: for, if there are many ways of living, there is only one natural way of dying. The rational analysis of death, however, has its own importance, constituting a sort of general corollary, convenient for the verification of the whole body of biological laws.

Of different organisms.

The popular notion of comparative biology is that it consists wholly of the last of the methods I have pointed out: and this shows how pre-eminent it is over the others; the popular exaggeration however being mischievous by concealing the origin of the art. The peculiarity of this largest application consists in its being founded on a very protracted comparison of a very extensive series of analogous cases, in which the modification proceeds by almost insensible graduated declension. The two more restricted methods could not offer a series of cases extensive enough to establish, without confirmation, the nature and value of the comparative method, though, that point once fixed, they may then come into unquestionable use. As for the value of the largest application, it demonstrates itself. There is clearly no structure or function whose analysis may not be perfected by an examination of what all organisms offer in common with regard to that structure and function, and by the simplification effected by the stripping away of all accessory characteristics, till the quality sought is found alone, whence the process of reconstruction can begin. It may even be fairly said that no anatomical arrangement, and no physiological phenomenon, can be really understood till the abstract notion of its principal element is thus reached, by successively attaching to it all secondary ideas, in the rational order prescribed by their greater or less persistence in the organic series. Such a method seems to me to offer, in biology, a philosophical character very like mathematical analysis genuinely applied; when it presents, as we have seen, in every indefinite series of analogous cases, the essential part which is common to all, and which was before hidden under the secondary specialties of each separate case. It can not be doubted that the comparative art of biologists will produce an equivalent result, up to a certain point; and especially, by the rational consideration of the organic hierarchy.

This great consideration was at first established only in regard to anatomy; but it is yet more necessary in physiology, and not less applicable, except from the difficulty of that kind of observation. In regard to physiological problems particularly, it should be remarked that not only all animal organisms, but the vegetable also, should be included in the comparison. Many important phenomena, and among others those of organic life, properly so called, can not be analyzed without an inclusion of the vegetable form of them. There we see them in their simplest and most marked condition, for it is by the great act of vegetable assimilation that brute matter passes really into the organized state, all ulterior transformations by means of the animal organization being much less marked. And thus, the laws of nutrition, which are of the highest importance, are best disclosed by the vegetable organism. The method is unquestionably applicable to all organs and all acts, without my exception; but its scientific value diminishes as it is applied to the higher apparatus and functions of the superior organisms, because these are restricted in proportion to their complexity and superiority. This is eminently the case with the highest intellectual and moral functions which below Man disappear almost entirely; or, at least, almost cease to be recognizable below the first classes of the mammifers. We can not but feel it to be an imperfection in the comparative method that it serves us least where we are most in need of all our resources; but it would be unphilosophical to deprive ourselves, even in this case, of the light which is cast upon the analysis of Man as moral, by the study of the intellectual and affective qualities of the superior animals, and of all others which present such attributes, however imperfect our management of the comparison may yet be. And we may observe that the comparative method finds a partial equivalent in the rational analysis of ages,—thus rendered more clear, extensive, and complete,—for the disadvantages which belong to the same stage of the biological hierarchy.

Thus I have presented the principal philosophical characters of the comparative method. It being the aim of biological study to ascertain the general laws of organic existence, it is plain that no course of inquiry could be more favorable than that which exhibits organic cases as radically analogous, and deducible from each other.

This study of our means of exploration has shown that our resources do indeed increase with the complexity of our subject. The two first methods—of Observation and Experiment—we have seen to acquire a large extension in the case of this science: while the third, before almost imperceptible, becomes, by the nature of the phenomena, well-nigh unbounded in its scope. We have next to examine the true rational position of Biology in the hierarchy of the fundamental sciences; that is, its relation to those that precede it, and to the one which follows it, in order to ascertain what kind and degree of speculative perfection it admits of, and what preliminary training is best adapted to its systematic cultivation. By this inquiry we shall see why we are justified in assigning to it a place between chemistry and social science.

Relation of Biology to other sciences.

Of the relation of Biology to social science, I need say little here, as I shall have to speak of it at length in another chapter. My task will then be to separate them, rather than to establish their connection, which it is the tendency of our time to exaggerate, through the spontaneous development of natural philosophy. None but purely metaphysical philosophers would at this day persist in classing the theory of the human mind and of society as anterior to the anatomical and physiological study of individual man. We may therefore regard this point as sufficiently settled for the present, and pass on to the relation of Biology to inorganic philosophy.

To Chemistry.

It is to chemistry that Biology is, by its nature, most directly and completely subordinated. In analyzing the phenomenon of life, we saw that the fundamental acts which, by their perpetuity, characterize that state, consist of a series of compositions and decompositions; and they are therefore of a chemical nature. Though in the most imperfect organisms, vital reactions, are widely separated from common chemical effects, it is not the less true that all the functions of the proper organic life are necessarily controlled by those fundamental laws of composition and decomposition which constitute the subject of chemical science. If we could conceive throughout the whole scale the same separation of the organic from the animal life that we see in vegetables alone the vital motion would offer only chemical conceptions, except the essential circumstances which distinguish such an order of molecular reactions. The general source of these important differences is, in my opinion, to be looked for in the result of each chemical conflict not depending only on the simple composition of the bodies between which it takes place, but being modified by their proper organization; that is, by their anatomical structure. Chemistry must clearly furnish the starting-point of every rational theory of nutrition, secretion, and, in short, all the functions of the vegetative life, considered separately; each of which is controlled by the influence of chemical laws, except for the special modifications belonging to organic conditions. If we now bring in again the consideration. discarded for the moment, of the animal life, we see that it could in no way alter this fundamental subordination, though it must greatly complicate its actual application: for we have seen that the animal life, notwithstanding its vast importance, can never be regarded in biology otherwise than as destined to extend and perfect the organic life, whose general nature it can not change. Such an intervention modifies, anew and largely, the chemical laws of the purely organic functions, so as to render the effect very difficult to foresee; but not the less do these laws continue to control the aggregate of the phenomena. If, for instance, a change in the nervous condition of a superior organism disturbs a given secretion, as to its energy or even its nature, we can not conceive that such an alteration can be of a random kind: such modifications, irregular as they may appear, are still submitted to the chemical laws of the fundamental organic phenomenon, which permit certain variations, but interdict many more. Thus, no complication produced by animal life can withdraw the organic functions from their subordination to the laws of composition and decomposition. This relation is so important, that no scientific theory could be conceived of in biology without it; since, in its absence, the most fundamental phenomena might be conceived of as susceptible of arbitrary variations, which would not admit of any true law. When we hear, at this day, on the subject of azote, such a doctrine as that the organism has the power of spontaneously creating certain elementary substances, we perceive how indispensable it still is to insist directly on those principles which alone can restrain the spirit of aberration.

Besides this direct subordination of biology to chemistry, there are relations of method between them. Observation and experimentation being much more perfect in chemistry, they serve as an admirable training for biological inquiry. Again, a special property of chemistry is its developing the art of scientific nomenclature; and it is in chemistry that biologists must study this important part of the positive method, though it can not, from the complexity of their science, be of so much scientific value as in chemistry. It is on the model of the chemical nomenclature that those systematic denominations have been laid down by which biologists have classified the most simple anatomical arrangements, certain well-defined pathological states, and the most general degrees of the animal hierarchy: and it is by a continued pursuit of the same method that further improvements will be effected.

We thus see why biology takes its place next after chemistry, and why chemical inquiries constitute a natural transition from the inorganic to the organic philosophy.

To Physics.

The subordination of biology to Physics follows from its relation to Chemistry: but there are also direct reasons, relating both to doctrine and method, why it should be so.

As to doctrine,—it is clear that the general laws of one or more branches of Physics must be applied in the analysis of any physiological phenomenon. This application is necessary in the examination of the medium, in the first place; and the analysis of the medium is required to be very exact, on account of the strong effect of its variations on phenomena so easily modified as those of the organism. And next, the organism itself is no less dependent on those laws, relating as they do to weight, heat, electricity, etc. It is obvious that if biology is related to chemistry through the organic life, it is related to Physics by the animal life,—the most special and noble of the sensations, those of sight and hearing, requiring for the starting-point of their investigation an application of optics and acoustics. The same remark holds good in regard to the theory of utterance, and the study of animal heat and the electric properties of the organism. It remains to be wished that the biologists would study and apply these laws themselves, instead of committing the task to physicists: but they have hitherto followed too much the example of the physicists, who, as we have seen, have committed the application of mathematical analysis in their own science to the geometers; whereas, it can not be too carefully remembered that if the more general sciences are independent of the less general, which, on the other hand, must be dependent on them, the students of the higher must be unfit, in virtue of that very independence, to apply them to a more complex science, whose conditions they can not sufficiently understand. If the case was clear in regard to the intrusion of the geometers into physics, it is yet more so with regard to the intrusion of the physicists into biology; on account of the more essential difference in the nature of the two sciences. The biologists should qualify themselves for the application of the preceding sciences to their own, instead of looking to the physicists for guidance which can only lead them astray.

In regard to Method, biology is indebted to physics for the most perfect models of observation and experimentation. Observations in physics are of a sufficient complexity to serve as a type for the same method in biology, if divested of their numerical considerations, which is easily done. Chemistry, however, can furnish an almost equally good model in simple observation. It is in experimentation that biologists may find in physics a special training for their work. As the most perfect models are found in the study of physics, and the method is singularly difficult in physiology, we see how important the contemplation of the best type must be to biologists. Such is the nature of the dependence, as to doctrine and method, of biology on physics. We turn next to its relations with Astronomy; and first, with regard to doctrine.

To Astronomy.

The relation of physiology to astronomy is more important than is usually supposed. I mean something more than the impossibility of understanding the theory of weight, and its effects upon the organism, apart from the consideration of general gravitation. I mean, besides, and more specially, that it is impossible to form a scientific conception of the conditions of vital existence without taking into the account the aggregate astronomical elements that characterize the planet which is the home of that vital existence. We shall see more fully, in the next book, how humanity is affected by these astronomical conditions; but we must cursorily review these relations in the present connection.

The astronomical data proper to our planet are, of course, statical and dynamical. The biological importance of the statical conditions is immediately obvious. No one questions the importance to vital existence of the mass of our planet in comparison with that of the sun, which determines the intensity of gravity; or of its form, which regulates the direction of the force; or of the fundamental equilibrium and the regular oscillations of the fluids which cover the greater part of its surface, and with which the existence of living beings is closely implicated; or of its dimensions, which limit the indefinite multiplication of races, and especially the human; or of its distance from the centre of our system, which chiefly determines its temperature. Any sudden change in one or more of these conditions would largely modify the phenomena of life. But the influence of the dynamical conditions of astronomy on biological study is yet more important. Without the two conditions of the fixity of the poles as a centre of rotation, and the uniformity of the angular velocity of the earth, there would be a continual perturbation of the organic media which would be incompatible with life. Bichat pointed out that the intermittence of the proper animal life is subordinate in its periods to the diurnal rotation of our planet; and we may extend the observation to all the periodical phenomena of any organism, in both the normal and pathological states, allowance being made for secondary and transient influences. Moreover, there is every reason to believe that, in every organism, the total duration of life and of its chief natural phases depends on the angular velocity proper to our planet; for we are authorized to admit that, other things being equal, the duration of life must be shorter, especially in the animal organism, in proportion as the vital phenomena succeed each other more rapidly. If the earth were to rotate much faster, the course of physiological phenomena would be accelerated in proportion; and hence life would be shorter; so that the duration of life may be regarded as dependent on the duration of the day. If the duration of the year were changed, the life of the organism would again be affected: but a yet more striking consideration is that vital existence is absolutely implicated with the form of the earth's orbit, as has been observed before. If that ellipse were to become, instead of nearly circular, as eccentric as the orbit of a comet, both the medium and the organism would undergo a change fatal to vital existence. Thus the small eccentricity of the earth's orbit is one of the main conditions of biological phenomena, almost as necessary as the stability of the earth's rotation; and every other element of the annual motion exercises an influence, more or less marked, on biological conditions, though not so great as the one we have adduced. The inclination of the plane of the orbit, for instance, determines the division of the earth into climates, and, consequently, the geographical distribution of living species, animal and vegetable. And again, through the alternation of seasons, it influences the phases of individual existence in all organisms; and there is no doubt that life would be affected if the revolution of the line of the nodes were accelerated; so that its being nearly immoveable has some biological value. These considerations indicate how necessary it is for biologists to inform themselves accurately, and without any intervention, of the real elements proper to the astronomical constitution of our planet. An inexact knowledge will not suffice. The laws of the limits of variation of the different elements, or, at least, a scientific analysis of the chief grounds of their permanence, are essential to biological investigation; and these can be obtained only through an acquaintance with astronomical conceptions, both geometrical and mechanical.

It may at first appear anomalous, and a breach of the encyclopedical arrangement of the sciences, that astronomy and biology should be thus immediately and eminently connected, while two other sciences lie between. But, indispensable as are physics and chemistry, astronomy and biology are, by their nature, the two principal branches of philosophy. They, the complements of each other, include in their rational harmony the general system of our fundamental conceptions. The solar system and man are the extreme terms within which our ideas will for ever be included. The system first, and then Man, according to the positive course of our speculative reason: and the reverse in the active process: the laws of the system determining those of Man, and remaining unaffected by them. Between these two poles of natural philosophy the laws of physics interpose, as a kind of complement of the astronomical laws; and again, those of chemistry, as an immediate preliminary of the biological. Such being the rational and indissoluble constitution of these sciences, it becomes apparent why I insisted on the subordination of the study of Man to that of the system, as the primary philosophical characteristic of positive biology.

Though in the infancy of the human mind, when it was in its theological state, and in its youthful metaphysical stage, the order of these sciences was reversed, there was a preparation for the true view. Through all the fanciful notions of the ancient philosophy about the physiological influence of the stars, we discern a strong though vague perception of some connection between vital and celestial phenomena. Like all primitive intuitions of the understanding, this one needed only rectification by the positive philosophy; under the usual condition, however, of being partially overthrown in order to be reorganized. But modern students, finding no astronomical conditions in the course of their anatomical and physiological observations, have discarded the idea of them altogether, —as if it were possible for facts to bear immediate testimony to the conditions without which they could not exist, and which do not admit of a moment's suspension! Such an order of primitive conditions is however now established beyond dispute. In order to prevent any return to vicious or exaggerated notions about the physiological influence of the stars, it is enough to bear in mind two considerations: first, that the astronomical conditions of vital existence are comprised within our own planetary system; and, secondly, that they relate, not directly to the organism, but to its environment, affecting as they do the constitution of our globe.

In regard to method,—the importance of astronomical study to biologists consists, as in other cases, in its offering the most perfect model of philosophizing on any phenomena whatever; the importance of this example becoming greater in proportion to the complexity of the subordinate science, on account of the stronger temptation to discursive and idle inquiries offered by the latter. The more difficult their researches become, the more sedulous should physiologists be to refresh their positive forces at the source of positive knowledge; and, in the contemplation of the few general and indisputable conceptions which constitute this lofty science, to be on their guard against the baseless notions of a vital principle, vital forces, and entities of that character. Hitherto, all advance in positivity in biology has been obtained at the expense of its dignity, which has always been implicated with an imaginary origin of life, of sensibility, etc.: but when physiologists have learned from their study of gravitation and other primary laws how to confine themselves to true science, their subject will rise to the highest elevation that positivity admits of,—that rational prevision of events which is, as I have so often said, the end of true science:—an end to be aimed at in biology, as it is perfectly fulfilled in astronomy.

Here, too, must biologists learn the character of sound scientific hypothesis. This method is eminently wanted in so complex a study as physiology; but it has been as yet used with very little effect. The way is, undoubtedly, to determine the organ from the function, or the function from the organ. It is permissible to form the most plausible hypothesis as to the unknown function of a given organ, or the concealed organ of a manifest function. If the supposition be in harmony with existing knowledge, if it be held provisionally, and if it be capable of a positive verification, it may contribute to the progress of discovery, and is simply a use of a right of the human mind, exercised as in astronomy. The only eminent example known to me of sound hypothesis in biology is that of M. Broussais, in proposing the mucous membrane of the alimentary canal as the seat of so-called essential fevers. Whether he was mistaken or not, is not the question. His hypothesis being open to unquestionable confirmation or subversion, it gave a great impulse to the study of pathology in a positive manner: and it will stand in the history of the human mind, as the first example of the spontaneous introduction of a sound hypothetical method into the positive study of living beings: a method derived from the region of astronomy.

It remains to consider the relation of biology to mathematics.

To mathematics.

The encroachments of the pure geometers upon the domain of biology have been attended with the same mischief, but in an aggravated form, that we have witnessed in the case of other sciences. This mischief has led physiologists to repudiate mathematics altogether,and open an impassable gulf between themselves and the geometers. This is a mistake; inasmuch as their science cannot be severed from that which is the basis of the whole of natural philosophy; and it is only through the admission of this that they can maintain the originality and independence of their scientific labors. The rational study of nature proceeds on the ground that all phenomena are subject to invariable laws, which it is the business of philosophical speculation to discover. It is needless to prove that on any other supposition, science could not exist, and our collections of facts could yield no result. In the phenomena of living bodies, as in all others, every action proceeds according to precise, that is, mathematical laws, which we should ascertain if we could study each phenomenon by itself. The phenomena of the inorganic world are, for the most part, simple enough to be calculable: those of the organic world are too complex for our management: but this has nothing to do with any difference in their nature. And this is the view which both geometers and biologists should bear in mind.

If in astronomy our calculations are baffled when we pass beyond two or three essential conditions, it is evident how impracticable they must be amidst the inextricable complications of physiology. And again, this complexity prevents our ever effecting a mathematical disclosure of the elementary laws of the science. This excludes all idea of this method of philosophizing in biology; for these laws are no otherwise accessible than by the immediate analysis of their numerical effects. Now, whichever way vital phenomena are looked at, they present such endless and incessant variations in their numbers, that geometers are baffled as completely as if those degrees were entirely arbitrary. Even numerical chemistry is inapplicable to bodies whose molecular composition varies incessantly; and this is precisely the distinguishing character of living organisms. However hurtful may have been the incursions of the geometers, direct and indirect, into a domain which it is not for them to cultivate, the physiologists are not the less wrong in turning away from mathematics altogether. It is not only that without mathematics they could not receive their due preliminary training in the intervening sciences: it is further necessary for them to have geometrical and mechanical knowledge, to understand the structure and the play of the complex apparatus of the living, and especially the animal organism. Animal mechanics, statical and dynamical, must be unintelligible to those who are ignorant of the general laws of rational mechanics. The laws of equilibrium and motion are, as we saw when treating of them, absolutely universal in their action, depending wholly on the energy, and not at all on the nature of the forces considered: and the only difficulty is in their numerical application in cases of complexity. Thus, discarding all idea of a numerical application in biology, we perceive that the general theorems of statics and dynamics must be steadily verified in the mechanism of living bodies, on the rational study of which they cast an indispensable light. The highest orders of animals act, in repose and motion, like any other mechanical apparatus of similar complexity, with the one difference of the mover, which has no power to alter the laws of motion and equilibrium. The participation of rational mechanics in positive biology is thus evident. Mechanics can not dispense with geometry; and besides, we see how anatomical and physiological speculations involve considerations of form and position, and require a familiar knowledge of the principal geometrical laws which may cast light upon those complex relations.

In regard to method, the necessity of recurring to a perfect model of reasoning, the more earnestly in proportion to the complexity of the science concerned, is applicable in regard to Mathematics, as to Astronomy; only with still greater urgency. In mathematics we find the primitive source of rationality; and to mathematics must the biologists resort for means to carry on their researches. If biologists have hitherto not done this, but contented themselves with what is called logic, apart from all determinate reasoning, much of the fault is chargeable upon the indifference of geometers about duly organizing the whole of mathematical knowledge. The imperfect and inadequate character of the elementary treatises on mathematics that have hitherto been given to the world quite accounts for the neglect of the fundamental logical properties of mathematical science by even intelligent minds. It accounts also for the exaggerations of some philosophers, who maintain that, far from preparing the intellectual organ for the rational interpretation of nature, a mathematical education rather tends to develop a spirit of sophistical argumentation and illusory speculation. Such an abuse, however, can not affect the real value of mathematics as a means of positive education; but rather exhibits the necessity of a philosophical renovation of the whole system of mathematical instruction. Whatever advantage can be attributed to logic in directing and strengthening the action of the understanding is found in a higher degree in mathematical study, with the immense added advantage of a determinate subject, distinctly circumscribed, admitting of the utmost precision, and free from the danger which is inherent in all abstract logic—of leading to useless and puerile rules, or to vain ontological speculations. The positive method, being everywhere identical, is as much at home in the art of reasoning as anywhere else: and this is why no science, whether biology or any other, can offer any kind of reasoning, of which mathematics does not supply a simpler and purer counterpart. Thus, we are enabled to eliminate the only remaining portion of the old philosophy which could even appear to offer any real utility; the logical part, the value of which is irrevocably absorbed by mathematical science. Hither, then, must biologists come, to study the logical art so as to apply it to the advancement of their difficult researches. In this school must they learn familiarly the real characters and conditions of scientific evidence, in order to transfer it afterward to the province of their own theories. The study of it here, in the most simple and perfect cases, is the only sound preparation for its recognition in the most complex.

The study is equally necessary for the formation of intellectual habits; for obtaining an aptitude in forming and sustaining positive abstractions, without which the comparative method can not be used in either anatomy or physiology. The abstraction which is to be the standard of comparison must be first clearly formed, and then steadily maintained in its integrity, or the analysis becomes abortive: and this is so completely in the spirit of mathematical combinations, that practice in them is the best preparation for it. A student who can not accomplish the process in the more simple case may be assured that he is not qualified for the higher order of biological researches, and must be satisfied with the humbler office of collecting materials for the use of minds of another order. Hence arises another use of mathematical training—that of testing and classifying minds, as well as preparing and guiding them. Probably as much good would be done by excluding the students who only encumber the science by aimless and desultory inquiries, as by fitly instituting those who can better fulfil its conditions.

Use of scientific fictions.

There seems no sufficient reason why the use of scientific fictions, so common in the hands of geometers, should not be introduced into biology, if systematically employed, and adopted with sufficient sobriety. In mathematical studies, great advantages have arisen from imagining a series of hypothetical cases, the consideration of which, though artificial, may aid the clearing up of the real subject, or its fundamental elaboration. This art is usually confounded with that of hypotheses; but it is entirely different, inasmuch as in the latter case the solution alone is imaginary; whereas, in the former, the problem itself is radically ideal. Its use can never be in biology comparable to what it is in mathematics; but it seems to me that the abstract character of the higher conceptions of comparative biology renders them susceptible of such treatment. The process would be to intercalate, among different known organisms, certain purely fictitious organisms, so imagined as to facilitate their comparison, by rendering the biological series more homogeneous and continuous; and it might be that several might hereafter meet with more or less of a realization among organisms hitherto unexplored. It may be possible, in the present state of our knowledge of living bodies, to conceive of a new organism capable of fulfilling certain given conditions of existence. However that may be, the collocation of real cases with well-imagined ones, after the manner of geometers, will doubtless be practised hereafter, to complete the general laws of comparative anatomy and physiology, and possibly to anticipate occasionally the direct exploration. Even now, the rational use of such an artifice might greatly simplify and clear up the ordinary system of pure biological instruction. But it is only the highest order of investigators who can be intrusted with it. Whenever it is adopted, it will constitute another ground of relation between biology and mathematics.

We have now gone over all those grounds—both of doctrine and of method. Of the three parts of mathematics, Mechanics is connected with biology in the scientific point of view; and geometry in the logical: while both rest upon the analytical theories which are indispensable to their systematic development.

This specification of the relations of biology determines its rank in the hierarchy of sciences. From this again we learn the kind and degree of perfection of which biology is susceptible; and, more directly, the rational plan of preliminary education which it indicates.

Condition and prospects of the science.

If the perfection of a science were to be estimated by the means of its pursuit, biology would evidently excel all others; for we can concentrate upon it the whole of the resources of observation and of reasoning offered by all the others, together with some of high importance appropriate to itself. Yet, all this wealth of resources is an insufficient compensation for the accumulated obstacles which beset the science. The difficulty is not so much in its recent passage into the positive state as in the high complexity of its phenomena. After the wisest use of all our resources, this study must ever remain inferior to all the departments of inorganic philosophy, not excepting chemistry itself. Still, its speculative improvement will be greater than might be supposed by those who are unaware how incomplete and barren is the accumulation of observations and heterogeneous conceptions which now goes by the name of the science. All that has yet been done should be regarded as a preliminary operation—an ascertainment and trial of means, hitherto provisional, but henceforth to be organized. Such an organization having really taken place among a few qualified investigators, the state of the science may be regarded as very satisfactory. As for the direct establishment of biological laws, the few positive ideas that we have obtained justify the expectation that the science of living bodies may attain to a real co-ordination of phenomena, and therefore to their prevision, to a greater or smaller extent.

Requisite Education.

As for the requisite education—as it comprehends the study of the preceding sciences, from mathematics downward, it is clearly of a more extensive and difficult order than any hitherto prescribed. But the time saved from the useless study of words, and from futile metaphysical speculations, would suffice for all the purposes of the regenerated science, which discards these encumbrances.

If, next, we look at the reaction of the science on the education of the general mind, the first thing that strikes us is that the positive study of Man affords to observers the best test and measure of the mental power of those who pursue the study. In other sciences, the real power of the inquirer and the value of his acquisitions are concealed from popular estimate by the scientific artifices which are requisite for the pursuit; as in the case of mathematics, whose hieroglyphic language is very imposing to the uninitiated: so that men of extremely small ability, rendering very doubtful services, have obtained a high reputation for themselves and their achievements. But this can hardly take place in biology; and the preference which popular good sense has accorded to the study of Man as a test of scientific intelligence is therefore well-grounded. Here the most important phenomena are common to all; and the race may be said to concur in the study of Man: and, the more difficult and doubtful the ascertainment of general laws in so complex a science, the higher is the value of individual and original meditation. When these laws become better known, this originality will yield some of its value to the ability which will then be requisite for their application. The moral world will, under all future, as under all past circumstances, regard the knowledge of human nature as the most indubitable sign, and the commonest measure, of true intellectual superiority.

The first intellectual influence of the science is in perfecting, or rather developing, two of the most important of our elementary powers, which are little required by the preceding sciences;—the arts of comparison and of classification, which, however necessary to each other, are perfectly distinct. Of the first, I have said enough; and of the second I shall speak hereafter; so that I have now only to indicate its function in biology.

Art of classification.

The universal theory of philosophical classifications, necessary not only to aid the memory but to perfect scientific combinations, can not be absent from any branch of natural philosophy: but it is incontestable that the full development of the art of classification was reserved for biological science. As we have seen before, each of our elementary powers must be specially developed by that one of our positive studies which requires its most urgent application, and which, at the same time, offers it the most extended field. Under both aspects, biology tends, more than any other science, to favor the spontaneous rise of the general theory of classifications. First, no other so urgently claims a series of rational classifications, on account both of the multiplicity of distinct but analogous beings, and of the necessity of organizing a systematic comparison of them in the form of a biological hierarchy; and next, the same characteristics which demand these classifications facilitate their spontaneous establishment. The multiplicity and complexity are not, as might at first appear. obstacles to the systematic arrangement of subjects: on the contrary, they are aids, as the diversity of their relations offers a greater number of analogies, more extensive and easy to lay hold of. This is the reason why the classification of animals is superior to that of vegetables; the greater variety and complexity of animal organisms affording a better hold for the art of classifying. And thus we see that the very difficulties of the science are of a nature at once to require and permit the most marked and spontaneous development of the general art of classification; and hither must the student in every other department of science resort, to form his conceptions of this all-important method. Here alone can geometers, astronomers, physicists, and even chemists learn the formation of natural groups, and their rational co-ordination; and yet more, the general principle of the subordination of characteristics, which constitutes the chief artifice of the method. The biologists alone, at this day, can be in habitual possession of clear and positive ideas in these three relations.—Each of the fundamental sciences has, as we have already so often seen, the exclusive property of specially developing some one of the great logical procedures of which the whole positive method is composed; and it is thus that the more complex, while dependent on the simpler, react on their superiors by affording them new rational powers and instruments. In this view of the hierarchical character and unity of the system of human knowledge, it becomes clear that the isolation still practised in the organization of our positive studies is as hurtful to their special progress as to their collective action upon the intellectual government of the human race.

Influence of Biology upon the Positive spirit.

Looking now to the higher functions of this science—its influence upon the positive spirit, as well as method—we have only to try it by the test proposed before;—its power of destroying theological conceptions in two ways:—by the rational prevision of phenomena, and by the voluntary modification of them which it enables Man to exercise. As the phenomena of any science become more complex, the first power decreases, and the other increases, so that the one or the other is always present to show, unquestionably, that the events of the world are not ruled by supernatural will, but by natural laws. Biological science eminently answers to this test. While its complexity allows little prevision, at present, in regard to its phenomena, it supplies us with a full equivalent, in regard to theological conceptions, in the testimony afforded by the analysis of the conditions of action of living bodies. The natural opposition of this species of investigation to every kind of theological and metaphysical conception is particularly remarkable in the case of intellectual and affective phenomena—the positivism of which is very recent, and which, with the social phenomena that are derived from them, are the last battle-ground, in the popular view, between the positive philosophy and the ancient. In virtue of their complexity, these phenomena are precisely those which require the most determinate and extensive concurrence of various conditions, exterior and interior; so that the positive study of them is eminently fitted to expose the futility of the abstract explanations derived from the theological or metaphysical philosophy. Hence, we easily understand the marked aversion which this study is privileged to arouse among different sects of theologians and metaphysicians. As the labors of anatomists and physiologists disclose the intimate dependence of moral phenomena on the organism and its environment, there is something very striking in the vain efforts of followers of the old philosophies to harmonize with these facts the illusory play of supernatural influences or psychological entities. Thus has the development of biological science put the positive philosophy in possession of the very stronghold of the ancient philosophy. The same effect becomes even more striking in the other direction, from biological phenomena being, beyond all others, susceptible of modification from human intervention. We have a large power of affecting both the organism and its environment, from the very considerable number of the conditions which concur in their existence: and our voluntary power of disturbing phenomena, of suspending, and even destroying them, is so striking as to compel us to reject all idea of a theological or metaphysical direction. As in the other case, of which indeed it is a mere extension, this effect is most particularly marked in regard to moral phenomena, properly so called, which are more susceptible of modification than any others. The most obstinate psychologist could not well persist in maintaining the sovereign independence of his intellectual entities, if he would consider that the mere standing on his head for a moment would put a complete stop to the course of his own speculations. Much as we may wish that, in addition to these evidences, we had that of an extensive power of scientific prevision in biology, such a power is not needed for the conclusions of popular good sense. This prevision is not always baffled: and its success in a few marked cases is sufficient to satisfy the general mind that the phenomena of living bodies are subject, like all others, to invariable natural laws, which we are prevented from interpreting in all cases only by their extreme complexity.

But, moreover, positive biology has a special conquest of its own over the theological and metaphysical systems, by which it has converted an ancient dogma into a new principle. In chemistry the same thing occurred when the primitive notion of absolute creation and destruction was converted into the precise conception of perpetual decomposition and recomposition. In Astronomy, the same thing occurred when the hypothesis of final causes and providential rule gave place to the view of the solar system as the necessary and spontaneous result of the mutual action of the principal masses which compose it. Biology, in its close connection with astronomy, has completed this demonstration. Attacking, in its own way, the elementary dogma of final causes, it has gradually transformed it into the fundamental principle of the conditions of existence, which it is the particular aptitude of biology to develop and systemize. It is a great error in anatomists and physiologists—an error fatal to both science and theology—to endeavor to unite the two views. Science compels us to conclude that there is no organ without a function, and no function without an organ. Under the old theological influences, students are apt to fall into a state of anti-scientific admiration when they find the conditions and the fulfilment coincide—when, having observed a function, anatomical analysis discloses a statical position in the organism which allows the fulfilment of the function. This irrational and barren admiration is hurtful to science, by habituating us to suppose that all organic acts are effected as perfectly as we can imagine, thus repressing the expansion of our biological speculations, and inducing us to admire complexities which are evidently injurious: and it is in direct opposition to religious aims, as it assigns human wisdom as the rule and even the limit of the divine, which, if such a parallel is to be established, must often appear to be the inferior of the two. Though we can not imagine radically new organisms, we can, as I showed in my suggestion about the use of scientific fictions, conceive of organizations which should differ distinctly from any that are known to us, and which should be incontestably superior to them in certain determinate respects. The philosophical principle of the conditions of existence is in fact simply the direct conception of the necessary harmony of the statical and the dynamical analyses of the subject proposed. This principle is eminently adapted to the science of biology, which is continually engaged in establishing a harmony between the means and the end; and nowhere else, therefore, is seen in such perfection, that double analysis, statical and dynamical, which is found everywhere.

These, then, are the philosophical properties of positive biology. To complete our review of the science as a whole, we have only to note briefly the division and rational co-ordination of its parts.

Distribution of the science.

It does not fall within the scope of this work to notice several branches of positive biological knowledge, which are of extreme importance in their own place, but secondary in regard to the principles of positive philosophy. We have no concern here with pathology, and the corresponding medical art; nor with natural history, and the corresponding art of the education of organisms. These are naturally, and not untruly, called biological studies: but we must here confine the term strictly to the speculative and abstract researches which are the foundation of the science. The interior distribution of the science, thus regarded, is this.

The speculative and abstract study of the organism must be divided, first, into statics and dynamics; according as we are seeking the laws of organization or those of life: and again, statical biology must be divided into two parts, to which M. de Blainville has given the name, in regard to animals, of *zootomy* and *zootaxy*, according as we study the structure and composition of individual organisms, or construct the great biological hierarchy which results from the comparison of all known organisms. It would be easy to modify M. de Blainville's terms so as to make them common to animals and vegetables. Dynamical biology, to which we may give the name *bionomy*, as the end and aim of the whole set of studies evidently admits of no analogous subdivision. The general name of Biology thus includes the three divisions, biotomy, biotaxy, and pure bionomy, or physiology properly so called.

Their definition exhibits their necessary dependence ; and thereby determines also their philosophical co-ordination. While it is universally allowed that anatomical ideas are indispensable to physiological studies, because the structure must be known before its action can be judged of, the subordination of bionomy to biotaxy is not so well understood. Yet it is easy to see that the place of any organism in the scale must be known before its aggregate phenomena can be effectually studied : and again, the consideration of this hierarchy is indispensable to the use of that grandest instrument of all,—the comparative method. Thus, from every point of view, the double relation of dynamical to statical biology is unquestionable.

The two divisions of statical biology are less clearly marked ; and it even appears as if, in regard to them, we were involved in a vicious circle : for if, on the one hand, the rational classification of living beings requires the antecedent knowledge of their organization, it is certain, on the other hand, that anatomy itself, like physiology, can not be studied, in regard to all organisms, without an antecedent formation of the biological hierarchy. Thus we must admit a consolidation of the respective advancements of biotomic and biotaxic studies, through their intimate connection. In such a case, as a separation and determinate co-ordination are required by our understandings, it appears to me that we can not hesitate to make a dogmatic arrangement,—placing the theory of organization before that of classification,—for the last is absolutely dependent on the first ; while the first could meet some wants, though in a restricted way, without the second. In a word, none but known organisms can be classified ; whereas they all can and must be studied, to a certain extent, without being mutually compared. And again, there is no reason why, in a systematic exposition of anatomical philosophy, we should not borrow directly from biotaxy its construction of the organic hierarchy ; an anticipation which involves much less inconvenience than severing the complete study of structure.—However, it most be always borne in mind that any system will have to undergo a general revision, with a view to bringing out the essential relations of its parts : the relations, not only of the two sections of statical biology, but of both to the dynamical. This consideration goes far to diminish the importance assigned to these questions of priority : and the only reason why such a revision appears more necessary in biology than in the other science is, that there is a profounder accordance between its departments than we find in theirs.

The interior distribution of these three departments is determined, as usual, by the order of dependence of phenomena, on the ground of their relative generality. Thus, the theory of the organic life precedes that of the animal: and the theory of the highest functions and organs of Man terminates the biological system.

Where to begin.

It has often been a question whether, in studying each organ and function in the whole scale, it is best to begin at the one end or the other;—to begin with Man or the simplest known organism. I do not consider this question so all-important as it is often supposed, as all qualified inquiries admit the necessity of using the two methods alternately, whichever is taken first: but I think that a distinction should be made between the study of the organic and that of the animal life. The functions of the first being chemical, it is less necessary to begin with Man; and I think there may be a scientific advantage in studying the vegetable organism first, in which that kind of functions is the more pure and more marked, and therefore the more easily and completely studied: but every investigation, anatomical or physiological, relating to animal life, most be obscure if it began elsewhere than with Man, who is the only being in which such an order of phenomena is immediately intelligible. It is evidently the obvious state of Man, more and more degraded, and not the indecisive state of the sponge, more and more improved, that we should pursue, through the animal series, when we are analyzing any of the constituent characters of animality. If we seem to be by this procedure deserting the ordinary course of passing from the most general and simple subject to the most particular and complex, it is only to conform the better to the philosophical principle which prescribes that very course, and which leads us from the most known subjects to the least known. In all cases but this, the usual course is the fittest, in biological studies.

Here we conclude our review of biological science as a whole. The extent to which I have carried out the survey will allow us to consider its separate portions very briefly. In doing so, I shall follow the order just laid down, passing from the simple considerations of pure anatomy to that positive study of phenomena of the intellect and the affections, as the highest part of human nature, which will carry us over from biology to Social Physics,—the final object of this work.

CHAPTER II.

ANATOMICAL PHILOSOPHY.

Development of Statical biology.

It was during the second half of the last century that Daubenton and Vicq-d'Azyr achieved the extension of the statical study of living bodies to the whole of known organisms; and the lectures and writings of Cuvier carried on, and spread abroad, the regenerating influence of this great view. But, indispensable as was this conception to the development of anatomical science, it could not complete the character of statical biology without the aid and addition of Bichat's grand idea of the general decomposition of the organism into its various elementary tissues; the high philosophical importance of which appears to me not yet to be worthily appreciated.

The natural development of comparative anatomy would, no doubt, have disclosed this analysis to us sooner or later: but how slow the process would have been we may judge by what we see of the reluctance of comparative anatomists to abandon the exclusive study of systems of organs while unable to deny the preponderant importance of the study of the tissues. Of all changes, those which relate to method are the most difficult of accomplishment; and perhaps there is no example of their resulting spontaneously from a regular advance under the old methods, without a direct impulsion from a new original conception, energetic enough to work a revolution in the system of study. Biology must, from its great complexity, be more dependent on such a necessity than any other science.

Process of discovery of the tissues.

Though zoological analysis furnishes the best means of separating the various organic tissues, and especially of giving precision to the true philosophical sense of this great notion, pathological analysis offered a more direct and rapid way to suggest the first idea of such a decomposition, even regarding the human organism alone. When pathological anatomy had been once founded by Morgagni, it was evident that in the best-marked maladies no organ is ever entirely diseased, and that the alterations are usually confined to some of its constituent parts, while the others preserve their normal condition. In no other way could the distinction of the elementary tissues have been so clearly established. By the co-existence in one organ of sound and impaired tissues, and, again, by different organs being affected by similar maladies, in virtue of the disease of a common tissue, the analysis of the chief anatomical elements was spontaneously indicated, at the same time that the study of the tissues was shown to be more important than that of the organs. It is not consistent with my objects to go further into this: but it was necessary to show that we owe to pathological analysis the perception of this essential truth. It was Pinel who suggested it to Bichat, by his happy innovation of studying at once all the diseases proper to the different mucous membranes. Bichat then, while knowing nothing of the study of the organic hierarchy, carried off from the students of comparative anatomy the honor of discovering the primitive idea which is most indispensable of all to the general advancement of anatomical philosophy. His achievement consisted in rationally connecting with the normal condition a notion derived from the pathological condition, in virtue probably of the natural reflection that if the different tissues of the same organ could each be separately diseased in its own way, they must have, in their healthy condition, distinct modes of existence, of which the life of the organ is really composed. This principle was entirely overlooked before Bichat published the treatise in which he established the most satisfactory *à-posteriori* development of it: and it is now placed beyond all question. The only matter of regret is that, in creating a wholly new aspect of anatomical science, Bichat did not better mark its spirit by the title he gave it. If he had called it *abstract* or *elementary* instead of *general* anatomy, he would have indicated its philosophical function, and its relation to other anatomical points of view.

Combination with comparative anatomy.

The anatomical philosophy began to assume its definitive character from the very recent time when the human mind learned to combine the two great primitive ideas of the organic hierarchy, and of Bichat's discovery, which applies the universal conception to the statical study of living bodies. These combined ideas are necessarily the subject of our present examination. Putting aside the irrational distinctions, still too common among biologists, of many different kinds of anatomy, we must here recognise only one scientific anatomy, chiefly characterized by the philosophical combination of the comparative method with the fundamental notion of the decomposition of the organs into tissues. It is apparently strange that, after Bichat's discovery, comparative anatomists, with Cuvier at their head, should have persisted in studying organic apparatus in its complex state, instead of beginning with the investigation of these tissues, pursuing the analysis of the laws of their combinations into organs, and ending with the grouping of those organs into apparatus, properly so called: but not even Cuvier's great name can now prevent the application of the comparative method to the analysis of tissues, throughout the whole biological hierarchy. The work, though at present neither energetically nor profoundly pursued, is begun, and will reform the habitual direction of anatomical speculation.

Bichat's studies related to Man alone; and his method of comparison bore only upon the simplest and most restricted cases of all; the comparison of parts and that of ages. His principle must therefore, necessarily undergo some transformations, to fit it for a more extensive application. The most important of these improvements, especially in a logical view, appears to me to consist in the great distinction introduced by M. de Blainville between the true anatomical *elements* and the simple *products* of the organism, which Bichat had confounded. We saw before the importance of this distinction in the chemical study of organic substances: and we meet it again now, face to face, as an anatomical conception.

Elements and Products.

We have seen that life, reduced to the simplest and most general notion of it, is characterized by the double continuous motion of absorption and exhalation, owing to the reciprocal action of the organism and its environment, and adapted to sustain during a certain time, and within certain limits of variation, the integrity of the organization. It results from this that, at every instant of its existence, every living body must present, in its structure and decomposition, two very different orders of principles: absorbed matters in a state of assimilation, and exhaled matters in a state of separation. This is the ground of the great anatomical distinction between organic elements and organic products. The absorbed matters, once completely assimilated, constitute the whole of the real materials of the organism. The exhaled substances, whether solid or fluid, become, from the time of their separation, foreign to the organism, in which they can not generally remain long without danger. Regarded in a solid state, the true anatomical elements are always necessarily continuous in tissue with the whole of the organism: and again, the fluid elements, whether stagnant or circulating, remain in the depths of the general tissue, from which they are equally inseparable: whereas the products are only deposited, for a longer or shorter time, on the exterior or interior surface of the organism. The differences are not less characteristic, in a dynamical view. The true elements alone must be regarded as really living: they alone participate in the double vital motion: and they alone grow or decrease by absorption or exhalation. Even before they are finally excreted, the products are already essentially dead substances, exhibiting the same conditions that they would manifest anywhere else, under similar molecular influences.

The separation of the elements from the products is not always easy to effect, when, as frequently happens, they combine in the same anatomical arrangement to concur in the same function. All products are not, like sweat, urine, etc., destined to be expelled without further use in the organic economy. Several others, as saliva, the gastric fluid, bile, etc., act as exterior substances, and in virtue of their chemical composition in preparing for the assimilation of the organic materials. It is difficult to fix the precise moment when these bodies cease to be products and become elements; the moment, that is, when they pass from the inorganic to the organic state,—from death to life. But these difficulties arise from the imperfection of our analysis, and not from any uncertainty in the principle of separation. It may be observed, however, that there are circumstances in which products, and particularly among the solids, are closely united to true anatomical elements in the structure of certain apparatus, to which they supply essential means of improvement. Such are, for instance, the greater number of epidermic productions, the hair, and eminently the teeth. But even in this case, a sufficiently delicate dissection, and a careful analysis of the whole of the function will enable us to ascertain, with entire precision, how much is organic and how much inorganic in the proposed structure. Such an investigation was not prepared for when Bichat confounded the teeth with the bones, and concluded the epidermis and the hair to be tissues, of a piece with the cutaneous tissue; but the rectification which ensued was all-important, as enabling us to define the idea of tissue or *anatomical element*, which is the preferable term. It was through comparative anatomy that the rectification took place; for the study of the biological series showed that the inorganic parts, which in Man appear inseparable from the essential apparatus, are, in fact, only simple means of advancement, gradually introduced at assignable stages of the ascending biological series.

If we assert that, in the order of purely anatomical speculations, the study of products must be secondary to that of elements, it will not be supposed that we undervalue the study of products. This study is of extreme importance in physiology, whose principal phenomena would be radically unintelligible without it; and without it, pathological knowledge must come to a stand. As results, they indicate organic alterations; and as modified, they exhibit the origin of a great number of those alterations. In fact, the knowledge of them is much promoted by their separation from the anatomical elements, which withdraw the attention of biologists from the real claims of the whole class of products.

The consideration of products being once dismissed to its proper place, anatomical analysis has assumed its true character of completeness and clearness. Thus we may undertake now what was before impossible—an exact enumeration of anatomical elements. And again, these tissues can be classified according to their true general relations; and may even be reduced to a single tissue, modified by determinate laws. These two are the other chief transformations undergone by the great anatomical theory of Bichat, through the application of the comparative method: and these two we now proceed to review.

Vitality of the organic fluids.

The first is connected with the great question of the vitality of the organic fluids, about which our ideas are far from being, I think, sufficiently settled. Every living body consists of a combination of solids and fluids, the respective proportions of which vary, according to the species, within very wide limits. The very definition of the vital state supposes this conjunction; for the double motion of composition and decomposition which characterizes life could not take place among solids alone;

and, on the other hand, a liquid or gaseous mass not only requires a solid envelop, but could admit of no real organization. If the two great primitive ideas of Life and Organization were not inseparable, we might imagine the first to belong to fluids, because they are so readily modified; and the other to solids, as alone capable of structural formation: and here, under another view, we should find the necessary harmony of the two elements. The comparison of types in the biological series confirms, in fact, the general rule that the vital activity increases with the preponderance of fluid elements in the organism; while a greater persistence of the vital state attends the preponderance of solids. This has long been regarded as a settled law by philosophical biologists, in studying the series of ages alone. These considerations seem to show that the controversy about the vitality of fluids rests, like many other famous controversies, on a vicious proposal of the problem, since such a mutual relation of the solids and the fluids excludes at once both humorism and solidism. Discarding, of course, the products from the question, there can be no doubt that the fluid elements of the organism manifest a life as real as that of the solids. The founders of modern pathology, in their reaction against the old humorism, have not paid sufficient attention, in the theory of diseases, to the direct and spontaneous alterations of which the organic fluids, especially the blood, are remarkably susceptible, in virtue of the complexity of their composition. It would appear, from a philosophical point of view, very strange if the most active and susceptible of the anatomical elements did not participate, primarily or consecutively, in the perturbations of the organism. But, on the other hand, it is not less certain that the fluids, animal and vegetable, cease to live as soon as they have quitted the organism; as, for instance, the blood after venesection. They then lose all organization, and are in the condition of products. The vitality of the fluids, considered separately, constitutes then an ill-defined and therefore interminable question.

A truly positive inquiry, however, arises out of the question—the inquiry as to which of the immediate principles of a fluid are vital; for it can not be admitted that all are so indiscriminately. Thus, the blood being chiefly composed of water, it would be absurd to suppose such an inert vehicle to participate in the life of the fluid; but then, which of the other constituents is the seat of life? Microscopic anatomy gives us the answer,—that it resides in the globules, properly so called, which are at once organized and living. However valuable such a solution would be, it can be regarded at present only as an attempt; for it is admitted that these globules, though determinate in form, shrink more and more as the arterial blood passes through an inferior order of vessels,—that is, as it approaches its incorporation with the tissues; and that, at the precise moment of assimilation, there is a complete liquefaction of the globules. It would thus appear that we must cease to regard the blood as living at the very moment when it accomplishes its chief act of vitality. Before any decision can be made, we must have the counter proof,—the acknowledgment that true globules are exclusively characteristic of living fluids, in opposition to those which, as simple products, are essentially inert, and hold in suspension various solids, which make them difficult to be distinguished from true globules, notwithstanding the determinate form of the latter. Microscopical observations are too delicate, and sometimes deceptive, to admit at present of the irreversible establishment of this essential point of anatomical doctrine.

The statical study of living bodies would form but a very incomplete introduction to the dynamical, if the fluids were left out of the investigation of the organic elements, however much remains to be desired in our knowledge of them. The omission of them in Bichat's treatise leaves a great gap. Still, as the anatomy of solids must always take precedence of that of fluids, Bichat chose the true point of departure, though he did not undertake the whole subject. It must be added that the examination of the fluids is so much the more difficult of the two as to be well nigh impracticable. In an anatomical sense, it is impracticable: and the only two methods—microscopical and chemical examination—are impaired by the rapid disorganization which ensues when the fluids quit the organism. The chemical method is in itself the more valuable of the two: but, besides that the chemists habitually confound the elements and the products, they have always examined the former in a more or less advanced state of decomposition: and being unaware of this, they have offered only the most false and incoherent notions of the molecular constitution of the organized fluids. In such a state of things, it is only by a full preparation, from the study of the solid elements, that anything can be done in the study of the fluids. It is almost needless to say that by the same rule which prescribes this order, we should study fluids in the order of their increasing liquefaction,—taking the fatty substances first, then the blood and other liquids, and lastly the vaporous and gaseous elements, which will always be the least understood.

Classification of the tissues.

The order of inquiry being thus settled, the next subject is the rational classification of the tissues, according to their anatomical filiation. It was not by such a study as Bichat's,—that of Man alone,—that anything certain could become known of such obscure differences as those of the fundamental tissues. In order to obtain such knowledge, the study of the whole biological series is indispensable.

ORGANIC. Cellular tissue.

The first piece of knowledge thus obtained is that the cellular tissue is the primitive and essential web of every organism; it being the only one that is present through the whole range of the scale. The tissues which appear in Man so multiplied and distinct, lose all their characteristic attributes as we descend the series, and tend to merge entirely in the general cellular tissue, which remains the sole basis of vegetable, and perhaps of the lowest animal organization. The fact harmonizes well with the philosophical account of the basis of life, in its last degree of simplicity; for the cellular tissue is eminently fitted, by its structure, for absorption and exhalation. At the lower end of the series, the living organism, placed in an unvarying medium, does nothing but absorb and exhale by its two surfaces, between which are ever oscillating the fluids destined for assimilation, and those which result from the contrary process. For so simple a function as this, the cellular tissue suffices. It remained to be ascertained under what laws the original tissue becomes gradually modified so as to engender all the others, with those attributes which at first disguise their common derivation: and this is what Comparative anatomy has begun to establish, with some distinctness.

The characteristic modifications of the tissue are of two prominent classes: the first, more common and less profound, are limited to the simple structure: the other class, more special, and more profound, affect the composition itself.

Dermous tissue.

Of the first order the prominent case is that of the dermous tissue, properly so called, which is the basis of the general organic envelope, exterior and interior. The modification here is mere condensation, differently marked, in regard to animal organisms, according as the surface is, as in exterior surfaces, more exhalant than absorbent, or, as in interior surfaces, more absorbent than exhalant. Even this first transformation is not rigorously universal; and we must ascend the scale a little way to find it clearly characterized. Not only in some of the lowest of the animal organisms, are the exterior and interior essentially alike, so that the two surfaces may be interchanged, but, if we go a little lower, we find no anatomical distinction between the envelope and the whole of the organism, which is uniformly cellular.

Sclerous tissue.

By an increasing condensation of the parent tissue, three distinct but inseparable tissues proceed from the derma, all of which are destined to an important, though passive office in the animal economy, either as envelopes protecting the nervous organs, or as auxiliaries of the locomotive apparatus. These are the fibrous, cartilaginous, and bony tissues, ranged by Bichat in their rational order, and named by M. Laurent, in their combination, the *sclerous* tissue. The different degrees of consolidation here arise from the deposition in the cellular network of a heterogeneous substance, organic or inorganic, the extraction of which leaves no doubt as to the nature of the tissue. When, on the other hand, by a last direct condensation, the original tissue becomes itself more compact, without being incrusted by a foreign substance, we recognise a new modification, in which impermeability becomes compatible with suppleness, which is the characteristic of the serous, or (as M. Laurent calls it) the *kystous* tissue, the office of which is to interpose between the various mobile organs, and to contain liquids, both circulating and stagnant.

Kystous tissue.

ANIMAL.
Muscular and nervous tissues.

The second order of transformations exhibits two secondary kinds of tissue which distinguish the animal organism, and which appear at about the same degree of the scale—the muscular and the nervous tissues. In each there is an anatomical combination of the fundamental tissue with a special organic element, semi-solid and eminently vital, which, having long gone by the name of *fibrine*, in the first case, has suggested the corresponding name of *neurine* (given us by M. de Blainville) for the other. Here the transformation of the parent tissue is so complete, that it would be difficult to establish, and yet more to detect it in the higher organisms; but the analogies of comparative anatomy leave no doubt, and only make us wish that we could understand with more precision the mode of anatomical union of the muscular and nervous substances with the cellular tissue.

Passing on to the chief subdivision of each of the secondary tissues, the first consideration is of the general position, which is always related to a modification, greater or smaller, of the structure itself. Comparative analysis shows us that in the case of both the muscular and the nervous system, the organization of the tissue becomes more special and elevated, exactly in proportion to its deeper position between the exterior and interior surfaces of the animal envelope. Thence arises the rational division of each of these systems into superficial and profound. This distinction is more especially remarkable with regard to the nervous system, arranged, first, in the form of filaments, and afterward that of ganglions, with or without external apparatus.

This is the family of tissues, the study of which forms the basis of anatomical analysis. It would be departing from my object to inquire into the laws of composition under which the ascent is made from this primary study to that of porous substances, and thence on to the theory of the organs, and then to that of systems of organs, which would lead us on to physiological analysis. I have fulfilled the aim of this section in exhibiting the methodical connection of the four degrees of anatomical speculation, about which no real uncertainty exists. Deeper than this we can not go. The last term in our abstract, intellectual decomposition of the organism is the idea of tissue. To attempt the passage from this idea to that of molecule, which is appropriate to inorganic philosophy, is to quit the positive method altogether: and those who do so, under the fancy that they may possibly establish a notion of organic molecules, and who gave that vain search the name of transcendental anatomy, are in fact imitating the chemists in a region into which Chemistry must enter in its own shape where admissible at all, and are asserting in other words that, as bodies are formed of indivisible molecules, animals are formed of animalcules. This is simply an attempt, in the old spirit, to penetrate into the nature of existences, and to establish an imaginary analogy between orders of phenomena which are essentially heterogeneous. It is little creditable to the scientific spirit of our time that this aberration should call for exposure and rebuke, and that it should need to be asserted that the idea of tissue is, in organic speculation, the logical equivalent of the idea of molecule in inorganic speculation.

Limitation of the inquiry.

We here find ourselves in possession of a sufficient basis of anatomical science, while we need yet a more complete and profound combination of the ideas of comparative and textural anatomy This want will be supplied when we become universally familiarized with the four analytical degrees, complementary to each other, which must henceforth be recognised and treated as the basis of anatomical speculation.

CHAPTER III.

BIOTAXIC PHILOSOPHY.

After the statical analysis of living bodies, there must be a hierarchical co-ordination of all known, or even possible organisms, in a single series, which must serve as a basis for the whole of biological speculations. The essential principles of this philosophical operation are what I have now to point out.

Comparative anatomy of vegetables and animals.

We have already seen that it is the distinction of biological science to have developed the theory of classifications, which, existing in all sciences, attains its perfection when applied to the complex attributes of the animal organisms. In all ages, the vegetable organism was the direct subject of biological classification; but it was pursued on the principles furnished by the consideration of animals, whence the type was derived which guided philosophical speculation in the case. It could not be otherwise, so marked and incontestable as are the distinctions among animal organisms: and even the zoological classification of Aristotle, imperfect as it is, is infinitely superior to anything which could then have been attempted with regard to vegetables. This natural original classification has been rather rectified than changed by the labors of modern times; while that of vegetables has met with an opposite fate. As a fact, the first successful attempts in the animal region long preceded the establishment of the true principles of classification; whereas, it was only by a laborious systematic application of these principles that it has been possible, even within a century, to effect any rational co-ordination in the vegetable region, so little marked, in comparison, are the distinctions in the latter case. The natural result was that the animal realm, used as a type, became more and more attended to, till the improvements in zoological classification have gone so far as perhaps to lead us to fear that the vegetable organism, owing to its great simplicity, can never become subject to a much better classification than that in which it was left in the last century. The labors of the reformers of that time are very far indeed from having been useless; only, what they undertook for the vegetable kingdom has turned rather to the profit of the animal—an inevitable circumstance, since the property which rendered the animal kingdom the natural type of the taxonomical series must adapt it to receive all the improvements arising from the general principles of the theory. The character of the theory could not but remain incomplete, however, as long as the vegetable classification continued to be regarded as the chief end of the research; and the classification became rational only when it was seen that the vegetable region was the further end of the series, in which the most complex animal organism must hold the first place; an order of arrangement under which the vegetable organism will be more effectually studied than it ever was while made an object of exclusive investigation. All that is needed is that naturalists should extend to the whole series the anatomical and physiological considerations which have been attached too exclusively to animal organisms; and this will certainly be done now that the human mind is fairly established at the true point of view, commanding the fundamental theory of natural classification.

Animal anatomy our subject.

These prefatory remarks indicate our theme. We must have the whole series in view; but the animal region must be our immediate and explicit subject—both as furnishing the rational bases of the general theory of classification, and as exhibiting its most eminent and perfect application.

Division of the natural method.

The subject divides itself into two parts: the formation of natural groups, and their hierarchical succession—a division necessary for purposes of study, though the two parts ultimately and logically coalesce.

Natural group.

In contemplating the groups, the process is to class together those species which present, amidst a variety of differences, such essential analogies as make them more like each other than like any others—without attending, for the present, to the gradation of the groups, or to their interior distribution. If this were all, the classification must remain either doubtful or arbitrary, as the circumscription of each group could seldom be done so certainly as inevitably to include or exclude nothing that might not belong to another group: and great discordance was therefore observed in the early division into *orders*, *families*, and even *genera*. But the difficulty disappears on the foundation of the fundamental hierarchy, which rigorously assigns its place to each species, and clearly defines the ideas of *genera*, *families*, and *classes*, which henceforth indicate different kinds of decomposition, effected through certain modifications of the principle which graduates the whole series. The animal realm, especially in its higher parts, is as yet the only one in which the successive degrees have admitted a fully scientific description. The rough classification into natural groups was an indispensable preparation for the marshalling into a series of the immeasurable mass of materials presented by nature. The groups being thus separated, and the study of their interior distribution postponed, the innumerable throng of organic existences became manageable. This great benefit has misled botanists into the supposition that the formation of these groups is the most scientific part of the natural method—otherwise than as a preliminary process. The regular establishment of natural families offers, no doubt, great facilities to scientific study, by enabling a single case to serve for a whole group: but this is a wholly different matter from the value of the natural method, regarded, as it must henceforth be, as the highest rational means of the whole study, statical and dynamical, of the system of living bodies; and the great condition of which is that the mere position assigned to each body makes manifest its whole anatomical and physiological nature, in its relation to the bodies which rank before or after it. These properties could never belong to any mere establishment of natural families, if they could be grouped with a perfection which is far from being possible; for the arbitrary arrangement of the families, and the intermediate decomposition of each of them into species, would destroy all aptitude for comprehensive anatomical or physiological comparison, and open the way for that search after partial and secondary analogies which we see to be so mischievous in the study of the vegetable kingdom at this day.

Co-ordination of them.

The Natural Method, then, is philosophically characterized by the general establishment of the organic hierarchy, reduced, if desired, to the rational co-ordination of genera and even of families, the realization of which is found only in the animal region; and there only in an initiatory state. And the co-ordination proceeds under three great laws, which are these: first, that the animal species present a perpetually increasing complexity, both as to the diversity, the multiplicity, and the speciality of their organic elements, and as to the composition and augmenting variety of their organs and systems of organs. Secondly: that this order corresponds precisely, in a dynamical view, with a life more complex and more active, composed of functions more numerous, more varied, and better defined. Thirdly: that the living being thus becomes, as a necessary consequence, more and more susceptible of modification, at the same time that he exercises an action on the external world, continually more profound and more extensive. It is the union of these three laws which rigorously fixes the philosophical direction of the biological hierarchy, each one dissipating any uncertainty which might hang about the other two. Hence results the possibility of conceiving of a final arrangement of all living species in such an order as that each shall be always inferior to all that precede it, and superior to all that follow it, whatever might otherwise, from its nature, be the difficulty of ever realizing the hierarchical type to such a degree of precision as this.

Three laws of co-ordination.

All adequate inquirers are now agreed upon this conception as the starting-point of biological speculation; and I need not therefore stop to take notice of any prior controversies, except one, Question of permanence of organic species.

which is noticeable from its having tended to illustrate and advance the principle of the natural method. I refer to the discussion raised by Lamarck, and maintained, though in an imperfect manner, by Cuvier, with regard to the general permanence of organic species. The first consideration in this matter is, that whatever may be the final decision of this great biological question, it can in no way affect the fundamental existence of the organic hierarchy. Instead of there being, as Lamarck conjectured, no real zoological series, all animal organisms being identical, and their characteristics due to external circumstances, we shall see, by a closer examination, that the hypothesis merely presents the series under a new aspect, which itself renders the existence of the scale more clear and unquestionable than before; for the whole zoological series would then become, in fact and in speculation, perfectly analogous to the development of the individual; at least, in its ascending period. There would be simply a long determinate succession of organic states, gradually deduced from each other in the course of ages by transformations of growing complexity, the order of which, necessarily linear, would be precisely comparable to that of the consecutive metamorphoses of hexapod insects, only much more extended. In brief, the progressive course of the animal organism, which is now only a convenient abstraction, adapted to facilitate thought by abridging discourse, would thus be converted into a real natural law. This controversy, then, in which Lamarck showed by far the clearer and profounder conception of the organic hierarchy, while Cuvier, without denying, often misconceived it, leaves, in fact, wholly untouched the theory of the biological series, which is quite independent of all opinion about the permanence or variation of living species.

The only attribute of this series which could be affected by this controversy is the continuity or discontinuity of the organic progression: for, if we admit Lamarck's hypothesis, in which the different organic states succeed each other slowly by imperceptible transitions, the ascending series must evidently be conceived of as rigorously continuous; whereas, if we admit the stability of living species, we must lay down as a fundamental principle the discontinuousness of the series, without pretending, either, to limit, *à priori*, in any way the small elementary intervals. This is the question to be considered; and thus restricted, the discussion is of extreme importance to the general advancement of the Natural Method, which will be, in fact, much more clearly described if we are able to regard the species as essentially stable, and the organic series, therefore, as composed of distinctly separate terms, even at its highest stages of development; for the idea of *species*, which is the principal biotaxic unity, would no longer allow any scientific definition, if we must admit the indefinite transformation of different species into each other, under the sufficiently-prolonged influence of circumstances sufficiently intense. However certain might be the existence of the biological hierarchy, we should have almost insurmountable difficulty in realizing it; and this proves to us the high philosophical interest which belongs to this great question.

Lamarck's reasoning rested on the combination of these two incontestable but ill-described principles: first, the aptitude of any organism (and especially an animal organism) to be modified to a conformity to the exterior circumstances in which it is placed, and which solicit the predominant exercise of some special organ, corresponding to some faculty become requisite; and secondly, the tendency of direct and individual modifications to become fixed in races by hereditary transmission, so that they may increase in each new generation, if the environment remains unaltered. It is evident that if this double property is admitted without restriction, all organisms may be regarded as having been produced by each other, if we only dispose the environment with that freedom and prodigality so easy to the artless imagination of Lamarck. The falseness of this hypothesis is now so fully admitted by naturalists that I need only briefly indicate where its vice resides.

We need not stop to object to the immeasurable time required for each system of circumstances to effect such an organic transformation; nor yet to expose the futility of imagining organic environments, purely ideal, which are out of all analogy with existing media. We may pass on to the consideration that the conjecture rests on a deeply erroneous notion of the nature of the living organism. The organism and the medium must doubtless be mutually related; but it does not follow that either of them produces the other. The question is simply of an equilibrium between two heterogeneous and independent powers. If all possible organisms had been placed in all possible media, for a suitable time, the greater number of them would necessarily disappear, leaving those only which were accordant with the laws of the fundamental equilibrium; and it is probably by a series of eliminations like this that a biological harmony has become gradually established on our globe, where we see such a process now for ever going on. But the whole conception would be overthrown at once if the organism could be supposed capable of modification, *ad infinitum*, by the influence of the medium, without having any proper and indestructible energy of its own.

Though the solicitation of external circumstances certainly does change the primitive organization by developing it in some particular direction, the limits of the alteration are very narrow: so that, instead of wants creating faculties, as Lamarck would have us believe, those wants merely develop the powers to a very inconsiderable degree, and could have no influence at all without a primitive tendency to act upon. The disappearance of the superior races of animals before the encroachments of Man, shows how limited is the power of the organism to adapt itself to an altered environment; even the human barbarian gives way to civilized Man: and yet the power of adaptation is known to be greatest in the highest organ isms, whereas the hypothesis of Lamarck would require the fact to be the other way. In a statical view, too, this conception would compel us to regard the introductory animal as containing, at least in a rudimentary state, not only all the tissues (which might be admissible, reducible as they are to the cellular tissue), but all the organs and systems of organs; which is incompatible with anatomical comparison. Thus, in every view is Lamarck's conception condemned: and it even tends to destroy the philosophical balance between the two fundamental ideas of organization and life, by leading us to suppose most life where there is least organization. The lesson that we may learn from it is to study more effectually the limits within which, in each case, the medium may modify the organism, about which a very great deal remains to be learned: and meantime, there can scarcely be a doubt, especially after the luminous exposition of Cuvier, that species remain essentially fixed through all exterior variations compatible with their existence.

Cuvier's argument rests upon two chief considerations, complementary to each other;—the permanence of the most ancient known species; and the resistance of existing species to the most powerful modifying forces: so that, first, the number of species does not diminish; and next, it does not increase. We go back for evidence to the descriptions of Aristotle, twenty centuries ago: we find fossil species, identical with those before our eyes: and we observe in the oldest mummies even the simple secondary differences which now distinguish the races of men. And, as to the second view, we derive evidence from an exact analysis of the effects of domestication on races of animals and vegetables. Human intervention, affording as it does the most favorable case for alteration of the organism, has done nothing more, even when combined with change of locality, than alter some of the qualities, without touching any of the essential characters of any species; no one of which has ever been transformed into any other. No modification of race, nor any influences of the social state, have ever varied the fundamental and strongly-marked nature of the human species. Thus, without straying into any useless speculations about the origin of the different organisms, we rest upon the great natural law that living species tend to perpetuate themselves indefinitely, with the same chief characteristics, through any exterior changes compatible with their existence. In non-essentials the species is modified within certain limits, beyond which it is not modified, but destroyed. To know thus much is good: but we must remember that it teaches us nothing, with any completeness, of the kind of influence exercised by the medium on the organism. The rational theory of this action remains to be formed: and the laying down the question was the great result of the Lamarck controversy, which has thus rendered an eminent service to the progress of sound biological philosophy.

We may now proceed on the authorized conception that the great biological series is necessarily discontinuous. The transitions may ultimately become more gradual, by the discovery of intermediate organisms, and by a better directed study of those already known: but the stability of species makes it certain that the series will always be composed of clearly distinct terms separated by impracticable intervals. It now appears that the preceding examination was no needless digression, but an inquiry necessary to establish, in the hierarchy of living bodies, this characteristic property, so directly involved in the rational establishment of the hierarchy itself.

Two logical conditions of the study.

Having surveyed the two great conceptions of Natural Groups, and the biological series, which together constitute what is called the Natural Method, we must now notice two great logical conditions of the study. The first, or primordial, is the principle of the subordination of characters: the other, the final, prescribes the translation of the interior characters into exterior, which, in fact, results from a radical investigation of the same principle.

Subordination of characteristics.

From the earliest use of the natural method, even before the investigation had passed on from the natural groups to the series of them, it was seen that the taxonomic characters must be not only numbered but weighed, according to the rules of a certain fundamental subordination which must exist among them. The only subordination which is strictly scientific, and free from all arbitrary intermixture, is that which results from a comparative analysis of the different organisms: this analysis is of recent date, and even yet is adequately applied only in the animal region; and thus the subordination was no more than barely conceived of before the institution of comparative anatomy, and the weighing of attributes is closely connected with the conception of the organic hierarchy. The subordination of taxonomic characters is effected by measuring their respective importance according to the relation of the corresponding organs to the phenomena which distinguish the species under study,—the phenomena becoming more special as we descend to smaller subdivisions. In short, here as elsewhere, the philosophical task is to establish a true harmony between statical conditions and dynamical properties; between ideas of life and ideas of organization, which should never be separated in our scientific studies but in order to their ulterior combination. Thus our aim, sometimes baffled but always hopeful, is to subordinate the taxonomic characters to each other, without the admission of anything arbitrary into any arrangement of importance. We thus meet with gaps in our schedules which we should avoid, or be insensible to, under an arbitrary system; but we may subdue our natural impatience under this imperfection by accustoming our minds to regard rational classification as a true science, continually progressive, always perfectible, and therefore always more or less imperfect, like all positive science.

Procedure, in use of the Natural Method.

In conducting the process of comparison, the characters must be admitted without restriction, in virtue of their positive rationality, however inconvenient to manage and difficult to verify. This is the foundation of the proposed classification. The next step is to discard from the collection those whose verification would be too difficult, substituting for them some customary equivalents. Without this second process, which is as yet inadequately appreciated, the passage from the abstract to the concrete would be inextricably embarrassed. The anatomist and physiologist may be satisfied with a definition of groups which will not suit the zoologist, and still less the naturalist. The kind of transformations required is easily specified. First, it is clear how important it is to discard the characters which are not permanent, and those which do not belong to the various natural modifications of the species under study. They can be admitted only as provisional attributes till true equivalents, permanent and common, have been discovered. But the very nature of the problem indicates that the aim of the chief substitution should be to replace all the interior characters by exterior: and it is this which constitutes the main difficulty, and, at the same time, the highest perfection of this final operation. When such a condition is fulfilled, on the basis of a rational primitive classification, the natural method is irrevocably constituted, in the plenitude of its various essential properties, as we now find it in the case of the animal kingdom.

This transformation appears to be necessarily possible; for, as a chief characteristic of animality is action upon the external world and corresponding reaction, the most important primitive phenomena of animal life must take place at the surface of separation between the organism and its environment; and considerations with regard to this envelope, its form, consistence, etc., naturally furnish the principal distinctions of the different animal organizations. The interior organs, which have no direct and continuous relation to the medium, will always be of the highest importance among vegetative phenomena, the primitive and uniform basis of all life: but they are of secondary consequence in considering the degrees of animality; so that the interior part of the animal envelope, by which various materials for use are elaborated, is less important, in a taxonomic point of view, than the exterior part, which is the seat of the most characteristic phenomena. Accordingly, the transformation of interior into exterior zoological characters is not merely an ingenious and indispensable artifice, but a simple return from the distraction of an overwhelming mass of facts to a direct philosophical course of investigation. When therefore we see a recourse to interior characteristics in the study of the animal series, we must recognise the truth that not only is the classification as yet unfinished, but that the operation is imperfectly conceived of; that the inquirer has not ascended, through sound biological analysis, to the original source of analogies empirically discovered.

After thus ascertaining the nature of the Natural Method, we must, before quitting the subject, glance at the mode of its application in the co-ordination of the biological series, condensed into its principal masses.

Division of animal and vegetable kingdoms.

The most general division of the organic world is into the animal and vegetable kingdoms; a division which remains as an instance of thorough discontinuity, in spite of all efforts to represent it as an artificial arrangement. The deeper we go in the study of the inferior animals, the more plainly we perceive that locomotion, partial at least, and a corresponding degree of general sensibility, are the predominant and uniform characters of the entire animal series. These two attributes are even more universal in the animal kingdom than the existence of a digestive canal, which is commonly regarded as its chief exclusive characteristic: a predominance which would not have been assigned to this attribute of the organic life but for its being an inevitable consequence, and therefore an unquestionable test, of the double property of locomotion and sensibility; to which we must, in consequence, assign the first place. Such a transformation, however, relates only to moveable animals; so that for the rest. we should have still to seek some other yet more general indication of universal animality, if we must despair of finally discovering in it every direct anatomical condition of these two animal properties. As for the case of certain gyrating plants which appear to manifest some signs of these properties, our imperfect analysis of their motions discloses no true character of animality, since we can discover no constant and immediate relation with either exterior impressions or the mode of alimentation.

Hierarchy of the animal kingdom.

Next to the division of the two organic kingdoms comes the question of the rational hierarchy of the animal kingdom, by itself. In the place of the irrational considera tions, so much relied on formerly, of abode, mode of nutrition, etc., we now rest upon the supreme consideration of the greater or less complexity of the organism, of its relative perfection, speciality, elevation; in short, of the degree of animal *dignity*, as M. Jussieu has well expressed it. The next preparatory step was in the anatomical field, to determine the successive degrees of animality proper to the different organs. The combination of the two great inquiries,—into the bases of the zoological hierarchy as residing in the organization, and into the rank of the organs in their relation to life,—has furnished, since the beginning of this century, the first direct and general sketch of a definitive graduation of the animal kingdom. Henceforth, it became admitted that, as the nervous system constitutes the most animal of the anatomical elements, the classification must be directed by it; other organs, and, yet more, inorganic conditions, being recurred to only on the failure of the chief in the most special subdivisions; and the substitutes being employed according to their decreasing animality. Whatever share other zoologists may have contributed by their labors to the formation of this theory, it is to M. de Blainville that the credit of it especially belongs: and it is by his classification that we must proceed in estimating the application of the Natural Method to the direct construction of the true animal hierarchy.

Attribute of symmetry.

The happiest innovation which distinguishes this zoological system is that it attributes a high taxonomic importance to the general form of the animal envelope, which had before been neglected by naturalists, and which offers the most striking feature, in regard to description, in the symmetry which is the prevailing character of the animal organism. We must here reserve the case of the non-symmetrical animals; and this shows that the idea is insufficiently analyzed as yet. The principle is perhaps saved, or the difficulty distanced, by the fact that in these animals no trace can be discovered of a nervous system; but there is a sufficient want of precision and clearness to mark this as a case reserved for further analysis. We shall not wonder at this imperfection if we remember how erroneous were the notions, no further back than two generations ago, about very superior orders of animals—the whole of the radiated, a part of the mollusks, and even of the lower articulated animals. Among the orders thus restricted, there are two kinds of symmetry, the most perfect of which relates to a plane, and the other to a point, or rather to an axis: hence the further classification of animals into the duplicate and the radiated. It is impossible to admire too much the exactness with which an attribute, apparently so unimportant, corresponds with the aggregate of the highest biological comparisons, which are all found spontaneously converging toward this simple and luminous distinction. Still it remains empirical in its preponderance; and we yet need a clear and rational explanation, both physiological and anatomical, of the extreme necessary inferiority of the radiated to the duplicate animals, which, by their nature, must be nearer to Man, the fundamental unity in zoology.

Division of duplicate animals.

Taking the duplicate animals, or *artiozoaries*, their order is again divided according to the consistence of the envelope—whether it is hard or soft—and therefore more or less fit for locomotion. This is, in fact, a protraction of the last consideration, as symmetry must be more marked in the case of a hard than of a soft covering. The two great attributes of animality—locomotion and sensation—establish profound and unquestionable differences, anatomical and physiological, between these two cases; and we may easily connect them rationally with this primitive distinction, and perceive how they exhibit inarticulated animals as necessarily inferior to the articulated.

Division of articulated animals.

The articulated animals must next be distinguished into two great classes, according to the mode of articulation; whether under the envelope, by a bony skeleton, or a cartilaginous one, in the lowest degree; or whether the articulation is external, by the consolidation of certain horny parts of the envelope, alternating with the soft parts. The inferiority of this latter organization, especially with regard to the high functions of the nervous system, must be seen at a glance. It is observable that the more imperfect development of this eminently animal system always coincides with a fundamental difference in the position of its central part, which is always above the digestive canal in vertebrated animals, and below it in those which have an external articulation.

The rational hierarchy of the chief organisms in the upper part of the animal series is, then, composed of the three great classes; the vertebrated animals, those which are articulated externally, and the mollusks; or, in scientific language, the *osteozoaries*, the *entomozoaries*, and the *malacozoaries*.

Consideration of the envelope.

Glancing, finally, at the division of the first of these classes, I may remark that all former descriptions and definitions may merge in the consideration of the envelope. It will be enough here to refer merely to the secondary view of the envelope that of the inorganic productions which separate it from its environment. M. de Blainville has shown us how the descent from Man, through all the mammifera, the birds, the reptiles, amphibious animals, and fishes, is faithfully represented by the consideration of a cutaneous surface furnished with hair, feathers, scales, or left bare. The same determining importance of the envelope is perceived in the next order of animals, in which the descent is measured by the increasing number of pairs of locomotive appendages, from the hexapods to the myriapods, and even to the apodes, which are at the lower extremity.

It is not consistent with the object of this Work to go further into a description of the animal hierarchy. My aim in giving the above details has been to fix the reader's attention on my preliminary recommendation to study the present co-ordination of the animal kingdom as an indispensable concrete explanation of the abstract conceptions which I had offered, in illustration of the natural method. We must pass by, therefore, all speculations and studies which belong to zoological philosophy, and merely observe that there is one portion of the fundamental system which remains to be constituted, and the general principles of which are as yet only vaguely perceived;—I mean the rational distribution of the species of each natural genus. This extreme and delicate application of the taxonomic theory would have been inopportune at an earlier stage of the development of the science: but the time has arrived for it to be undertaken now.

Natural method applied to the Vegetable kingdom.

We can not but see that the natural method does not admit of anything like the perfection in the vegetable kingdom that it exhibits in even the lower stages of the animal. The families may be regarded as established, though in an empirical way; but their natural co-ordination remains almost entirely arbitrary, for want of a hierarchical principle by which to subordinate them rationally. The idea of animality yields a succession of degrees, deeply marked, so as to supply the basis of a true animal hierarchy: but there is nothing of the kind in our conception of vegetable existence. The intensity in this region is not always equal; but the character of vegetable life is homogeneous;—it is always assimilation and the contrary, continuous, and issuing in a necessary reproduction. The

Difficulty of co-ordination.

mere differences of intensity in such phenomena can not constitute a true vegetable scale, analogous to the animal; and the less because the gradation is owing at least as much to the preponderant influence of external circumstances as to the characteristic organization of each vegetable. Thus, we have here no sufficient rational basis for a hierarchical comparison. A second obstacle ought to be noticed—serious enough, though of less importance than the first;—that each vegetable is usually an agglommeration of distinct and independent beings. The case does not resemble that of the polypus formation. In the compound structure of the lowest animal orders a scientific definition is still possible. There is a vital basis common to all the animal structures which are otherwise independent of each other: but in the vegetable case, it is a mere agglomeration, such as we can often produce by grafting, and where the only common elements are inorganic parts, aiding a mechanical consolidation. There is no saying, in the present state of our knowledge, how far such a system may extend, without being limited by any organic condition, as it seems to depend on purely physical and chemical conditions, in combination with exterior circumstances. Faintly marked as the original organic diversity is by nature, it is evident how all rational subordination of the vegetable families in a common hierarchy is impeded by the coalescent tendency just noticed.

The principal division, which is the starting-point of M. Jussieu's classification, is the only beginning of a true co-ordination in the vegetable kingdom. It consists in distinguishing the vegetables by the presence or the absence of seminal leaves; and when they are present, by their having several or only one. For the successive passage from those which have several to those that have none may be regarded as a continuous descent, like that of the biological series, though less marked. Such a view has been verified by the investigation of the organs of nutrition, according to the discovery of Desfontaines—as yet the only eminent example of a large and happy application of comparative anatomy to the vegetable organism. By this concurrence of the two modes of comparison—of the reproductive and nutritive arrangements—this proposition has taken its rank among the most eminent theorems of natural philosophy. But this beginning of a hierarchy remains obviously insufficient—the numerous families in each of the three divisions remaining under a purely arbitrary arrangement, which we can hardly hope to convert into a rational one. The interior distribution of species, and even of genera, within each family must be radically imperfect, as the requisite taxonomical principles can not be applied to their arrangement till the difficulty of the co-ordination of the families—a difficulty much less, but as yet insurmountable—has been overcome. The Natural Method has, therefore, as yet yielded no other result, as to the vegetable kingdom, than the more or less empirical establishment of families and genera. We can not be surprised that it has not yet excluded the use of artificial methods.

and above all that of Linnæus—true as it is that, up to our time, the co-ordination of the vegetable kingdom was the field for the application of the Natural Method. It should ever be remembered, however, that the Natural Method is not merely a means of classification, but an important system of real knowledge as to the true relations of existing beings: so that even if it should be disused for the purposes of descriptive botany, it would not the less be of high value for the study of plants, the comparative results of which would be fixed and combined by it. In the present condition and prospects of the science, as to the establishment of a vegetable series, we must take the whole vegetable kingdom together as the last term of the great biological series—as the last of the small number of essential modes of organization which (when the subdivisions are disregarded) are markedly separated from each other in the classification that gives us the logical command of the study of living beings. Applied first to the vegetable kingdom, the natural method is now seen to be the means by which the animal realm, the type of all our knowledge of organic life, is to be perfected. To whatever orders of phenomena natural classification is to be applied, here its theory must first be studied; and hence it is that biological science bears so important a part in the advancement of the whole of the positive method. It is much that a considerable progress has been made in ranging, in a due order of dignity, the immense series of living beings, from Man to the simplest plant: but, moreover, this theory of classification is an indispensable element of the whole positive method; an element which could not have been developed in any other way, nor even otherwise appreciated.

CHAPTER IV.

ORGANIC OR VEGETATIVE LIFE.

Condition of Dynamical Biology.

We have to pass on to dynamical biology, which is very far indeed from having attained the clearness and certainty of the statical department of the science. Important as are the physiological researches of recent times, they are only preliminary attempts, which must be soundly systemized before they can constitute a true dynamical biology. The minds which are devoted to mathematical, astronomical, and physical studies, are not of a different make from those of physiologists; and the sobriety of the former classes, and the extravagance of the latter, must be ascribed to the definite constitution of the simpler sciences and the chaotic state of physiology. The melancholy condition of this last is doubtless owing in part to the vicious education of those who cultivate it, and who go straight to the study of the most complex phenomena without having prepared their understandings by the practice of the most simple and positive speculation: but I consider the prevalent license as due yet more to the indeterminate condition of the spirit of physiological science. In fact, the two disadvantages are one; for if the true character of the science were established, the preparatory education would immediately be rectified.

This infantine state of physiology prescribes the method of treating it here. I can not proceed, as in statical biology, to an analytical estimate of established conceptions. I can only examine, in pure physiology, the notions of method; that is, the mode of organization of the researches necessary to the ascertainment of the laws of vital phenomena. The progress of biological philosophy depends on the distinct and rational institution of physiological questions, and not on attempts, which must be premature, to resolve them. Conceptions relating to method are always important in proportion to the complexity of the phenomena in view; therefore are they especially valuable in the case of vital phenomena; and above all, while the science is in a nascent state.

Vital phenomena: their division.

Though all vital phenomena are truly interconnected, we must, as usual, decompose them for purposes of speculative study, into those of greater and those of less generality. This distinction answers to Bichat's division into the organic or vegetative life, which is the common basis of existence of all living bodies; and animal life, proper to animals, but the chief characters of which are clearly marked only in the higher part of the zoological scale. But, since Gall's time, it has become necessary to add a third division—the positive study of the intellectual and moral phenomena which are distinguished from the preceding by a yet more marked speciality, as the organisms which rank nearest to Man are the only ones which admit of their direct exploration. Though, under a rigorous definition, this last class of functions may doubtless be implicitly included in what we call the animal life, yet its restricted generality, the dawning positivity of its systematic study, and the peculiar nature of the higher difficulties that it offers, all indicate that we ought, at least for the present, to regard this new scientific theory as a last fundamental branch of physiology; in order that an unseasonable fusion should not disguise its high importance, and alter its true character. These, then, are the three divisions which remain for us to study, in our survey of biological science.

Theory of Organic Media.

Before proceeding to the analysis of organic or vegetative life, I must say a few words on the theory of organic media, without considering which, there can be no true analysis of vital phenomena.

This new element may be said to have been practically introduced into the science by that controversy of Lamarck, already treated of, about the variation of animal species through the prolonged influence of external circumstances. It is our business here to exclude from the researches thus introduced, everything but what concerns physiology, properly so called, reduced to the abstract theory of the living organism. We have seen that the vital state supposes the necessary and permanent concurrence of a certain aggregate of external actions with the action of the organism itself: it is the exact analysis of these conditions of existence which is the object of the preliminary theory of organic media; and I think it should be effected by considering separately each of the fundamental influences under which the general phenomenon of life occurs. It can not be necessary to point out the importance of the study of this half of the dualism which is the condition of life; but I may just remark on the evidence it affords of the subordination of the organic to the inorganic philosophy; the influence of the medium on the organism being an impracticable study as long as the constitution of the medium is not exactly known.

Exterior conditions of Life.

The exterior conditions of the life of the organism are of two classes—physical and chemical; or, in other words, mechanical and molecular. Both are indispensable; but the first may be considered, from their more rigorous and sensible permanence, the most general—if not as to the different organisms, at least as to the continued duration of each of them.

Mechanical conditions. Weight.

First in generality we must rank the action of Weight. There is no denying that Man himself must obey, whether as weight or projectile, the same mechanical laws that govern every other equivalent mass; and by reason of the universality of these laws, weight participates largely in the production of vital phenomena, to which it is sometimes favorable, sometimes opposed, and scarcely ever indifferent. There is great difficulty in the analysis of its effects, because its influence can not be suspended or much modified for the purpose; but we have ascertained something of them, both in the normal and the pathological states of the organism. In the lower, the vegetable portion of the scale, the physiological action of weight is less varied but more preponderant, the vital state being there extremely simple and least removed from the inorganic condition. The laws and limits of the growth of vegetables appear to depend essentially on this influence, as is proved by Mr. Knight's experiments on germination, as modified by a quicker or slower motion of rotation. Much higher organisms are subject to analogous conditions, without which we could not explain, for instance, why the largest animal masses live constantly in a fluid sufficiently dense to support almost their whole weight, and often to raise it spontaneously. However, the superior part of the animal series is least fit for the ascertainment of the physiological influence of weight, from its concurrence with a great number of heterogeneous actions; but this again enables us to study it in a variety of vital operations: for there is scarcely a function, organic, animal, or even intellectual, in which we may not point out the indispensable intervention of weight, which specially manifests itself in all that relates to the stagnation or movement of fluids. It is, therefore, much to be regretted that a subject so extended and important has not been studied in a rational spirit and method.

Pressure.

The next mechanical condition,—pressure, liquid or gaseous,—is an indirect consequence of weight. Some few scientific results have here been obtained, from the facility with which pressure may be modified by artificial or natural circumstances. There are limits in the barometrical scale, outside of which no atmospherical animal,—Man or any other,—can exist. We can not so directly verify such a law in the case of aquatic animals: but it would seem that in proportion to the density of the medium must be the narrowness of the vertical limits assignable to the abode of each species. Of the relation between these intervals and the degree of organization, it must be owned, however, that we have no scientific knowledge, our ideas being, in fact, wholly confused as to the inferior organisms, and especially in the vegetable kingdom. Though, through many difficulties and complexities, the science is in a merely nascent state, some inquiries, such as those relating to the influence of atmospheric pressure on the venous circulation, and recent observations on its co-operation in the mechanism of standing and moving, etc., show that biologists are disposed to study this order of questions in a rational manner.

Motion and rest.

Among the physical conditions, and perhaps first among them, the physiological influence of motion and rest should be investigated. Amidst the confusion and obscurity which exist on this subject, I think we may conclude that no organism, even the very simplest, could live in a state of complete immobility. The double movement of the earth, and especially its rotation may probably be as necessary to the development of life as to the periodical distribution of heat and light. Too much care, however, can not be taken to avoid confounding the motion produced by the organism itself with that by which it is affected from without; and the analysis had therefore better be applied to communicated than spontaneous motion. And as rotary motion tends, by the laws of mechanics, to disorganize any system, and therefore, eminently, to trouble its interior phenomena, it is this kind of motion which may be studied with the best result; for which object we should do well to investigate, in a comparative way, the modifications undergone by the principal functions from the organism being made to rotate in such a gradual variety as is compatible with a normal state. The attempt has as yet been made only with plants, and for another purpose; while, in the case of the superior animals, including Man, we have only incomplete and disjointed observations, scarcely transcending mere popular notions.

Thermological action.

After the mechanical influences, we reach one which affects structure—the thermological action of the medium. It is the best known of all; for nothing is plainer than that life can exist only within certain limits of the thermometrical scale, and that there are limits affecting every family, and ever every living race; and again, that the distribution of organisms over our globe takes place in zones sufficiently marked, as to differences of heat, to furnish thermometrical materials to the physicists, in a general way. But amidst the multitude of facts in our possession, all the essential points of rational doctrine are still obscure and uncertain. We have not even any satisfactory series of observations about the thermometrical intervals corresponding to the different organic conditions;—much less any law relating to such a harmony, which has never, in fact, been connected with any other essential biological character. This great gap exists as much with regard to the successive states of the same organism as to the scale of organisms. The necessary revision might be best applied first to the lowest states; as the egg and the lowest organisms appear able to sustain wider differences of temperature than those of a higher order; and several philosophical biologists have even believed that life may have been always possible on our planet, notwithstanding the different systems of temperature through which its surface has successively passed. On the whole, the sum of our analysis may seem to disclose, amidst many anomalies, a general law: that the vital state is so subordinated to a determinate thermometrical interval, as that this interval perpetually diminishes as life becomes more marked,—in the case both of the individual and of the series. If even this general law is not yet scientifically established, it may be supposed how ignorant we are of the modifications produced in the organism by variations of external temperature, within the limits compatible with life. There has even been much confusion between the results of abrupt and gradual changes of temperature, though experiment has shown that graduation vastly expands the limits within which the human organism can exist; and again, between the influence of external, and the organic production of vital heat. This last great error shows that even the laying down the question remains to be done. The same thing may be said of the other exterior conditions, such as light and electricity, of which all that we know in this connection is that they exert a permanent influence needful for the production and support of life. Besides the confusion and uncertainty of our observations, we have to contend with the inferiority of our knowledge of those branches of physics, and with the mischief of the baseless hypothesis which we before saw to infest the study of them. While physicists talk of fluids and ethers, avowing that they do so in an artificial sense, for purposes of convenience, physiologists speak of them as the real principles of two orders of exterior actions indispensable to the vital state. Till reform becomes substantial and complete in the study of light and electricity, these will remain the exterior conditions of vitality of which our knowledge is the most imperfect.

Light, Electricity, etc.

Molecular conditions.

Air and water.

Passing on from the physical to the chemical conditions of the medium, we find our amount of knowledge scarcely more satisfactory. In strict generality, this study relates to the physiological influence of air and water, the mingling of which in various degrees, constitutes the common medium necessary to vitality. As M. de Blainville remarked, they must not be considered separately, as in a physical or chemical inquiry, but in that mixture which varies only in the proportions of its elements. This might be anticipated from our knowledge of the chemical constitution of living bodies, the essential elements of which are found only in the combination of air and water: but we have physiological evidence also, which shows that air deprived of moisture, and water not aerated, are fatal to vital existence. In this view there is no difference between atmospheric and aquatic beings, animal and vegetable, but the unequal proportion of the two fluids; the air, in the one case, serving as a vehicle for vaporized water; and the water, in the other case, conveying liquefied air. In both cases, water furnishes the indispensable basis of all the organic liquids: and the air the essential elements of nutrition. We know that the higher mammifera, including Man, perish when the air reaches a certain degree of dryness, as fishes do in water which has been sufficiently deprived of air by distillation. Between these extreme terms there exists a multitude of intermediaries in which moister conditions of air and more aerated states of water correspond with determinate organisms; and the observation of Man in the different hygrometrical states of atmospheres shows how, in the individual case, physiological phenomena are modified within the limits compatible with the vital state. If we may say that the question has been laid down in this inquiry, it is only in a vague and obscure way. Besides our ignorance of the varying proportions, we have none but the most confused notions about the way in which each fluid participates in the support of life. Oxygen is the only element of the air about which we have made any intelligent inquiry, while physiologists entertain the most contradictory notions about azote: and the uncertainty and obscurity are still greater with regard to water. In this state of infancy, it can be no wonder that the science offers as yet no law as to the influence of the medium on the organism—even in regard to the question whether a certain condition of existence becomes more or less inevitable as the organism rises in the scale.

Study of specifics.

The study of the influence of specifics does not enter here, on account, of course, of the absence of generality; but it should be just pointed out that, reduced as is the number of substances called specifics, there are still enough,—as aliments, medicines, and poisons,—to afford a hint of what might be learned by an exploration of them, in regard to the harmony between the organic world and the inorganic. The very quality of their operation, that it is special and discontinuous, and therefore not indispensable, indicates the experimental method in this case, as being certain, well circumscribed, and very various. This study may then be regarded as a needful appendix, completing the preliminary biological doctrine which I have called that of organic media, and offering resources which are proper to it, and can not be otherwise obtained. Unhappily, this complement is in even a more backward state than the more essential portions, notwithstanding the multitude of observations, unconnected and unfinished, already assembled in this path of research.

History of Physiology.

If such is the state of preliminary knowledge, it is clear how little has yet been learned of the laws of life themselves. The inquiry has gone through revolutions, as other questions have, before reaching the threshold of positivity, in our day. From the impulse given by Descartes, the illustrious school of Boerhaave arose in physiology, which exaggerated the subordination of biology to the simpler parts of natural philosophy so far as to assign to the study of life the place of appendix to the general system of inorganic physics. From the consequent reaction against this absurdity arose the theory of Stahl, which may be considered the most scientific formula of the metaphysical state of physiology. The struggle has since lain between these two schools, —the strength of the metaphysical one residing in its recognition of physiology as a distinct science, and that of the physico-chemical, in its principle of the dependence of the organic on the inorganic laws, as daily disclosed more fully by the progress of science. The effect of this improved knowledge has been to modify the conceptions of metaphysical physiology: the formula of Barthez, for instance, representing a further departure from the theological state than that of Stahl; as Stahl's already did than that of Van Helmont, though the same metaphysical entity might be in view when Van Helmont called it the *archeus*, and Stahl the *soul*, and Barthez the *vital principle*. Stahl instituted a reaction against the physico-chemical exaggerations of Boerhaave; but Barthez established, in his preliminary discourse, the characteristics of sound philosophizing, and exposed the necessary futility of all inquisition into causes and modes of production of phenomena, reducing all real science to the discovery of their laws. For want of the requisite practice in the positive method, the scheme of Barthez proved abortive; and, after having proposed his conception of a vital principle as a mere term to denote the unknown cause of vital phenomena, he was drawn away by the prevalent spirit of his time to regard the assumed principle as a real and complex existence, though profoundly unintelligible. Ineffectual as his enterprise proved, its design with regard to the advancement of positive science can not be mistaken. The progressive spirit is still more marked in the physiological theory of Bichat, though we find entities there too. These entities, however, show a great advance, as a determinate and visible seat is assigned to them. The vital forces of Bichat, however, still intervene in phenomena, like the old specific entities introduced into physics and chemistry, in their metaphysical period, under the name of faculties or occult virtues, which Descartes so vigorously hunted down, and Molière so happily ridiculed. Such is the character of the supposed *organic sensibility*, by which, though a mere term, Bichat endeavored to *explain* physiological phenomena, which he thus merely reproduced under another name: as when, for instance, he thought he had accounted for the successive flow of different liquids in one canal by saying that the organic sensibility of the canal was successively in harmony with each fluid, and in antipathy to the rest. But for his untimely death, however, there can be no doubt that he would have issued into an entire positivity. His treatise on General Anatomy, though appearing a very few years after his treatise on Life and Death, is a great advance upon it; and even in the construction of his metaphysical theory of vital forces he certainly first introduced, under the title *properties of tissue*, a conception of the highest value, destined to absorb all ontological conceptions, and to prepare for the entire positivity of the elementary notions of physiology. The thing required is to substitute *properties* for *forces;* and Bichat's treatment of tissue fulfilled this condition with regard to a very extensive class of effects: and thus his theory, while it amended the metaphysical doctrine of Stahl and Barthez, opened the way to its entire reformation by presenting at once the germ and the example of purely positive conceptions. This is now the state of physiological philosophy in the minds of the majority of students; and the conflict between the schools of Stahl and Boerhaave,—between the metaphysical and the physico-chemical tendency,—remains at the point to which it was brought up by the impulse communicated by Bichat. It would be hopeless to look to the oscillations of this antagonism for an advance in science. If the one doctrine prevailed, science would be in a state of retrogression; if the other, in a state of dissolution; as in our social condition, in the conflict of the two political tendencies, the retrograde and the revolutionary. The progress of physiology depends on the growth of positive elementary conceptions, such as will remand to the domain of history the controversy from which nothing more is to be expected. Abundant promise of such an issue now appears: the two schools have annulled each other; and the natural development of the science has furnished means for its complete institution to be begun. This I look upon as the proper task of the existing generation of scientific men, who need only a better training to make them adequate to it. If, from its complexity, physiology has been later than other sciences in its rational formation, it may reach its maturity more rapidly from the ground having been cleared by the pursuit of the anterior sciences. Many delays were occasioned in their case by transitory phases which were not understood in the earlier days of positivity, and which need never again arrest experienced investigation. It may be hoped that physiologists will spare the science the useless and humbling delay in the region of metaphysical hypothesis which long embarrassed the progress of physics.

Philosophical character of Physiology.

The true philosophical character of physiology consists, as we have seen, in establishing an exact and constant harmony between the statical and the dynamical points of view,—between the ideas of organization and of life,

—between the notion of the agent and that of the act; and hence arises the obligation to reduce all abstract conceptions of physiological *properties* to the consideration of elementary and general phenomena, each of which conveys the idea of a determinate seat. In the other words, the reduction of *functions*, to corresponding *properties* must be regarded as the simple consequence of decompounding the general life into the different functions,—discarding all notions about *causes*, and inquiring only into *laws*. Bichat's conception of the properties of tissue contains the first germ of this renovated view; but it only indicates the nature of the philosophical operation, and contains no solution of the problem. Not only is there a secondary confusion between the properties of tissue and simple physical properties, but the principle of the conception is vitiated by the irrational distinction between the properties of tissue and vital properties; for no property can be admitted in physiology without its being at once vital and belonging to tissue. In endeavoring to harmonize the different degrees of physiological and of anatomical analysis, we may lay down the philosophical principle that the idea of *property* which indicates the last term of the one must correspond with *tissue*, which is the extreme term of the other; while the idea of *function*, on the other hand, corresponds to that of *organ:* so that the successive ideas of function and of property present a gradation of thoughts similar to that which exists between the ideas of organ and of tissue, except that the one relates to the act and the other to the agent. This relation appears to me to constitute an incontestable and important rule in biological philosophy; and on it we may establish the first great division among physiological properties. We have seen how in anatomy there is a division between the fundamental, generating tissue, the cellular, and the secondary tissues which result from the combination of certain substances with this original web; and in the same way must physiological properties be divided into two groups,—the one comprising the general properties which belong to all the tissues, and which constitute the proper life of the cellular tissue; and the other, the special properties which characterize its most marked modifications,—that is, the muscular and nervous tissues. This division, indicated by anatomy, strikingly agrees with the great philosophical distinction between the organic or vegetative and the animal life; as the first order of properties must afford the basis of that general life, common to all organized beings, to which vegetable existence is reduced; while the second relates exclusively to the special life of animated beings. Such a correspondence at once makes the principle more unquestionable, and facilitates the application of the rule.

Division of the study.

If we look at what has been done, toward the construction of this fundamental theory, we shall find that it is fairly accomplished with regard to the secondary, or animal tissues,—all the general phenomena of animal life being unanimously connected with irritability and sensibility,—these being considered as attributes each of a definite tissue: and thus, the most marked case is the best understood. But the other division,—the properties which are wholly general, belonging to the universal life, are far more important, as underlying the others; and an extreme confusion and divergence exist with regard to them. No clear and satisfactory conception of the second class can be formed while the first is left in obscurity; and thus, the science remains in a purely provisional state,—its development having taken place in an order inverse to that which its nature requires.

Two functions of the organic life.

The functions which belong to the vegetative life are two,—the antagonism of which corresponds to the definition of life itself: first, the interior *absorption* of nutritive materials from the surrounding medium; whence results, after their assimilation, final nutrition; and secondly, the *exhalation* of molecules, which then become foreign bodies, to be parted with, or disassimilated, as nutrition proceeds. It appears to be an error to make digestion and circulation characteristics of animality; as we certainly find them here in the fundamental sense of both. Digestion is properly a preparation of aliment for assimilation; and this takes place in a simple and almost unvaried manner in vegetable organisms: and circulation, though nothing like what it is in animals, where there is a central organ to effect it, is not less essential in vegetative life,—the lowest organism showing the continual motion of a fluid holding in suspension or dissolved, matters absorbed or thrown out; and this perpetual oscillation, which does not require a system of vessels to itself, but may take place through the cellular tissue, is equally indispensable to animal and vegetable existence. These, then, are the two great vegetative processes, performed by properties which are provisionally supposed (after the analysis of M. de Blainville, which is open to some objections) to be three,—hygrometricity, capillarity, and retractility. This analysis shows clearly that the actions which constitute vegetable life are simple physico-chemical phenomena; physical as to the motion of the molecules inward and outward; and chemical in what relates to the successive modifications of these different substances. Under the first aspect, they depend on the properties, hygrometrical, capillary, and retractile, of the cellular tissue: under the second, and much more obscure at present, they relate to the molecular action which its composition admits. This is the spirit in which the analysis of organic phenomena should be instituted; whereas that of animal phenomena should be regarded from a wholly different point of view, as we shall see hereafter.

The study of this vegetative life is not even yet rationally organized. We have seen that, in the anatomical view, the vegetable kingdom is regarded as the last term of a unique series,—the various degrees of which differ, for the most part, more widely from each other than any one of them from this extreme term. The same conception should direct physiological speculations on the organic life, analyzed uniformly for all living beings: but this has not hitherto been even attempted. Till it is accomplished, no essential point of physiological doctrine can be established, however able may be the investigations carried on, and however valuable the materials supplied. It may be alleged that the phenomena relating to the general life may be studied in the broadest simplicity in vegetable organisms: but it is no more possible in physiology than in anatomy to interpret the extreme cases in the scale by each other without having passed through the intermediate degrees: and the dynamical case is the more difficult of the two: so that the isolated study of the organic life in vegetables can not illustrate that of the higher order of animals. And one natural consequence of this irrational isolation of the vegetable case is that chemists and physicists have engrossed researches which properly belong to biologists alone. The comparative method, which we have seen to be the characteristic resource of biological philosophy, has not as yet been duly introduced into the general study of organic life, though it is at once more indispensable, and more completely applicable than in the case of animal life. If it were consistent with the character of this Work, we could point out gaps at almost every step, and about the simplest phenomena, which must shock any inquiring mind:—the darkness, doubts, and differences about digestion: and again about gaseous digestion, or respiration;—in regard to which the most contradictory opinions are held:—divergences about the simplest preliminary phenomena of vegetative life, which show how much has to be done before we can undertake any direct investigation into the phenomena of assimilation and the converse process.

Results of organic action.

State of composition and decomposition.

We shall find ourselves even further from satisfaction if we turn from the consideration of the *functions* of organic life to those more compound phenomena which are usually confounded with them, but which M. de Blainville has taught us to distinguish as *results* from the action of, not one organ or set of organs, as in the case of function, but of the simultaneous action of all the principal organs. Of these results, the most immediate and necessary is the continuous state of composition and decomposition which characterizes the vegetative life. Ignorant as we are of assimilation and secretion, the very questions can not have been as yet suitably laid down. No one has thought, for instance, of instituting an exact chemical comparison between the total composition of each organism and the corresponding system of alimentation: nor, conversely, between the exhaled products and the whole of the agents which had supplied or modified them; so that we can give no precise scientific account of the general phenomenon of the composition and decomposition of every organism as a necessary consequence of the concurrence of the different functions. We have at present only incomplete and disjointed materials, which have never been referred to any general fact.

Vital heat.

It is acknowledged now that all organisms have, more or less, the character which used to be ascribed to only the highest, of sustaining a determinate temperature, notwithstanding variations of heat in their environment; and this is a second result of the whole of the vegetative functions, which almost always co-exists with the first. But this important study is not only in a backward state, but ill-conceived. Besides the error before noticed, of confounding vital heat with the temperature of the medium, the fundamental character of the phenomenon appears to me to have been misconceived. Its modification by the animal functions can never be understood till it has been studied in its primitive universal manifestation in all living bodies, each of which represents a chemical centre, able to maintain its temperature against external influences, within certain limits, as a necessary consequence of the phenomena of composition and decomposition. This is doubtless the point of view from which the positive study of vital heat must be regarded; and to consider it under the modifications of animal life, is to place the accessory before the principal, and to propose views which are merely provisional, if not erroneous. In the most recent works upon this leading subject, the organic foundations are, it is true, more carefully considered: but the investigation can not be said to be duly instituted as long as the vegetable organism is not regularly introduced into it.

Electrical state.

These remarks are even more applicable to the electrical study of living bodies. Here we find again, and with aggravation, the confusion between organic action and external influence, as well as the aberrations remarked on in physics about ethers and electric fluids. Here, too, we meet with the error observed upon in the last case, about the physiological origin of the phenomenon. And here, again, we are bound to conclude that a permanent electrization is ascribable to acts of composition and decomposition, notwithstanding the electrical variations of the medium. And again we find that the animal functions can only modify, by accelerating or augmenting, more or less, the fundamental phenomenon. But the electrical analysis of the organism is yet further than the thermological from being conceived of and pursued in a rational view.

Production and development of living bodies.

Next follow the general phenomena which result in a less direct and necessary manner from the whole of the vegetative functions—the production and development of living bodies. Notwithstanding the original investigations of Harvey and of Haller, with regard to the superior animals, this investigation may be considered, owing to its complexity, to be more in the rear of a positive institution than any of the preceding. The tendency to search for causes and modes of production of phenomena, instead of for their laws, has acted with fatal effect here: and, amidst every kind of deficiency, the main cause of the obscurity of the case is, undoubtedly, that students have occupied themselves in looking for what can not be found. However, the labors of anatomists and zoologists have evidently prepared the way for a more rational study. It is even worthy of remark that some students who were most bent on the search into causes have been led on by the spread of the positive spirit, to spend their efforts on inquiries into ovology and embryology, which are assuming a more scientific character every day. Still, the preliminary requisite for the formation of doctrine—a fundamental analysis—remains unfulfilled; and the ascertainment of the laws of production and development is not, therefore, to be attempted at present. In the lowest departments of the scale, the multiplication of organisms takes place by a simple prolongation of any part of the parent mass, which is almost homogeneous; and in this extreme case, we understand the phenomenon to be analogous to every other kind of reproduction of the primitive cellular tissue. In the higher degrees of the scale, we are in the dark from the moment we depart from immediate observation; and when the simplest previsions are so radically uncertain and even erroneous as in this case, the science may be pronounced to be in a state of infancy, notwithstanding the imposing appearance of the mass of works accumulated for its illustration.

The comparative method has been applied in a yet more incomplete way to the phenomena of organic development. The question has never yet been laid down under a form common to all organisms, including the vegetable. The grave error is still committed of studying the development in the animal cases alone; so that the most eminently animal of the systems, the nervous, is represented as the first to appear in the embryo of the higher orders—a supposition adverse to the institution of any really general conception of the theory of development, and in direct opposition to one of the most constant laws of biological philosophy—the perpetual accordance between the chief phases of the individual evolution and the most marked successive degrees of the organic hierarchy; for in this last view the nervous tissue is seen to be the latest and most special transformation of the primitive tissues. The preliminary analysis of organic development is, then, still far from being conceived of in a rational spirit, governed by the high philosophical intention of reconciling, as much as possible, the various essential aspects of the science of living bodies.

Decline of the organism.

To be complete, this analysis should evidently be followed by the inverse, and yet correlative study of the decline of the organism, from its maturity to its death. The general theory of death is certainly in a very backward state, since the ablest physiological researches on this subject have usually related to violent or accidental death; considered, too, in the highest organisms exclusively, and affecting functions and systems of organs of an essentially animal nature. As for the deterioration of the organic life, we have yet attained to only one initiatory philosophical glimpse, which exhibits it as a necessary consequence of life itself, by the growing predominance of the movement of exhalation over that of absorption, whence results gradually an exaggerated consolidation of the organism which was originally almost fluid, a process which, in the absence of more rapid influences, tends to produce a state of desiccation incompatible with all vital phenomena. Valuable, however, as is such a glimpse, it serves only to characterize the true nature of the question, by indicating the general direction of the researches which it requires. The important considerations relative to animal life could not be rationally introduced into such a subject till this preliminary doctrine shall have been established; as in regard to all the other points of view before examined.

Summary as this review has been, we have seen enough to be authorized to conclude that the backward state of physiological science is owing mainly to the vicious training of physiologists, and the irrational institution of their habitual labors. The circulation of the blood, the first general fact which gave birth to positive physiology, and the laws of the fall of bodies, the first acquisition of sound physics, are discoveries almost absolutely contemporaneous; and yet, what an immense inequality there is now in the progress of two sciences setting out from so similar a disclosure! Such a difference can not be attributed wholly to the greater complexity of physiological phenomena, and must have depended much also on the scientific spirit which directed their general study, to the level of which the greater number of those who cultivate it have been unable to rise. The phenomena of the vegetative life obviously require, both for their analysis and their explanation, an intimate combination of the leading notions of inorganic philosophy with physiological considerations, obtained through a thorough familiarity with the preliminary laws relating to the structure and classification of living bodies. Now, each of these inseparable conditions is, in our day, the separate property of a particular order of positive investigators. Hence we have, on the one hand, the supposed organic chemistry, a bastard study, which is only a rough first sketch of vegetable physiology, undertaken by inquirers who know nothing of the true subject of their labors; and, on the other hand, vague, incoherent, and partly metaphysical doctrines, of which physiology has been chiefly constituted by minds almost entirely destitute of the most indispensable preliminary ideas. The barren anarchy which has resulted from so vicious an organization of scientific labor would be enough of itself to testify to the direct utility of the general, and yet positive point of view which characterizes the foregoing survey.

CHAPTER V.

THE ANIMAL LIFE.

It was only by a late and long-prepared effort that the human mind could attain that state of abstraction and physiological generality necessary for the comprehension of all vital beings—from Man to the vegetable—as one series. It is only in our own day that a point of view so new and so difficult has been established; and as yet, among only the most advanced minds, even as regards the simplest general aspects of biology—in the statical study of the organism. It is not at all surprising that physiological comparison should have been first applied to the animal functions, because they first suggest its importance and possibility, however clearly it may afterward appear that the organic life at once requires and admits a larger and more indispensable application of the comparative method. Looking more closely, however, into this evident existing superiority of animal over organic physiology, we must bear in mind the distinction between the two elementary aspects of every positive study—the analysis of phenomena and their explanation. It is only with regard to the first that the animal life has been in reality better explored than the organic. It is not possible that the explanation of the most special and complex phenomena should be more advanced than that of the most simple and general, which serve as a basis to the others. Such a state of the science would be in opposition to all the established laws of the human mind.

Transition from the inorganic to the organic.

However imperfect the theory of organic phenomena still is, it is unquestionably conceived in a more scientific spirit than we find in any explanations of animal physiology. We have seen that the vegetative phenomena approach most nearly to the inorganic; and that the school of Boerhaave sinned only in exaggeration, proceeding from insufficient knowledge; and it must be by this time evident that this is the link between the inorganic and the biological philosophy, by which we are enabled to regard the whole natural philosophy as forming a homogeneous and continuous body of doctrine. By a natural consequence, a wholly different view must be taken of the rational theories of animal life: that is, of the phenomena of irritability and sensibility, which offer no basis of analogy with inorganic phenomena. With regard to sensibility, no one will question this: and, as to irritability—though contraction may be seen as a movement occasioned by heat, and, yet more, by electricity, these phenomena must be carefully separated from the contractile effect of the irritable fibre which is a product of the nervous action; and especially when it is voluntary. Irritability is as radically foreign to the inorganic world as sensibility; with which, too, it is inseparably connected.

Primitive nervous properties.

This double property is, then, strictly primitive in the secondary tissues, and therefore no more a subject of explanation than weight, heat, or any other fundamental physical property. Whenever we have a true theory of animal life, it will be by comparing all the general phenomena which are connected with this double property, according to their preparatory analysis, in order to discover their laws; that is, as in all other cases, their constant relations, both of succession and similitude. This will be done in order to the usual end of obtaining a rational prevision, the subject here being the mode of action of a given animal organism, placed in determinate circumstances; or, reciprocally, the animal arrangement that may be induced by any given act of animality. All attempts to explore the nature of sensibility and irritability are mere hinderances in the way of this final aim, by drawing off our attention from the laws of animality in a vain search after what can never be found.

Relation of the animal to the organic life.

The true relation of the animal to the organic life must throughout be carefully kept in mind. This relation is double. The organic life first serves as the basis of the animal; and then as its general end and object. We have dwelt enough on the first, if even any one would think of contesting that, in order to move and feel, the animal must first live; and that the fundamental vegetative life could not cease without extinguishing the other. As for the second relation, it is evident that the phenomena of irritability and sensibility are directed by the general needs of the organic life, which they serve by procuring better materials, and by guarding against unfavorable influences. Even the intellectual and moral functions have usually no other primitive office. Without such a destination, these properties would either destroy the organism or themselves perish. It is only in the human species, and even there only under a high degree of civilization, that any kind of inversion of this order can be conceived of. In that case, the vegetative life is essentially subordinated to the animal, the development of which it is alone destined to aid; and this, it seems to me, is the noblest scientific notion that we can form of humanity, distinct from animality:—a transformation which can be safely considered as possible only by transferring to the whole species, or at least to society, the primitive end which, in the case of animals, is limited to the individual, or, at the utmost, to the family, as we shall see hereafter. It is only among a small number of men, and it is very far indeed from being a just matter of expectation from the whole species, that the intellect can acquire such a preponderance in the whole of the organism as to become the end and object of human existence. An exception so special, and so easy to explain in the case of Man, can not alter the universality of a consideration verified by the whole animal kingdom, wherein the animal life is seen to be always destined to perfect the organic. It is only by a scientific abstraction, necessary for purposes of progress, that we can provisionally conceive of the first as isolated from the second, which is, strictly speaking, inseparable from it under the double aspect just exhibited. Thus, as the positive theory of animality must continually rest on that of general vitality, it is indissolubly combined with the whole of inorganic philosophy, which furnishes the basis of organic physiology. In a secondary sense, the same dependence exists. We admitted, while reviewing mathematical philosophy, that the laws of equilibrium and motion operate among all orders of phenomena, being absolutely universal. Among physiological phenomena we find them accordingly; and, when contraction is produced by the irritability of the muscular fibre, all the phenomena of animal mechanics which result, whether for rest or locomotion, are dependent on the general laws of mechanics. In an inverse way the same thing takes place with regard to the functions of sensibility, in which the inorganic philosophy must intervene in connection with the primitive impression on the sentient extremities, carefully distinguished from its transmission by the nervous filament, and its perception by the cerebral organ. This impression acts through an intermediate physical apparatus, optical, acoustic, or other, the study of which according to appropriate physical laws, constitutes a chief element of the positive analysis of the phenomenon. Not only must we use the knowledge already established, but we want, for our analysis, further progress in it, and even the creation of new doctrines, as the theory of flavors, and yet more of odors, in regard to the mode of propagation of which there are doubtless several general laws, of a purely inorganic character, remaining to be established. In investigating these connections between biology and inorganic science, we find again what we saw before, that chemistry is spontaneously related to vegetable physiology, and physics especially to animal physiology; though neither could be altogether dispensed with in either department, where they are required, more or less, in combination.

To inorganic philosophy.

Properties of tissue.

Our ideas of the double property of irritability and sensibility can not be truly scientific till each is irreversibly assigned to a corresponding tissue. Bichat conceived of all tissues as necessarily sensitive and irritable, but in different degrees;—an error which was natural or inevitable at a time when so little was known of tissue in the way of anatomical analysis, but one which, if maintained now, would hand over the whole science to the physico-chemical school, and efface all real distinction between the inorganic and organic departments of natural philosophy. Rational biology requires that the two properties should be inherent in determinate tissues—themselves modifications, profound and distinctly marked, of the primitive cellular tissue—that our anatomical data may be in harmony with the physiological; in other words, that the elementary ideas of tissue and of property should be in perfect correspondence. The scientific character of physiology in this direction is essentially defective among biologists in general. But the new explorations continually made show us how it was that Bichat was misled. He considered it proved that sensibility existed where there were no nerves: but further investigation proves that the symptoms of sensibility were erroneously attributed to an organ deprived of nerves, instead of being referred to the simultaneous injury of neighboring nerves; or that the nervous tissue existed, though it was difficult to find. If cases apparently contradictory still remain, it would be obviously absurd to reject on their account a conception required by the principles of rational physiology, and founded on unquestionable cases, by far more numerous and decisive than those which still seem to be exceptional. This consideration should be applied to different organisms, as well as to the different tissues of the human organism. The animals supposed to be without nerves, on which the metaphysical school has insisted so much, disappear as comparative anatomy enables us to generalize more and more the idea of nervous tissue, and to detect it in the inferior organisms. It is thus, for instance, that it has been recently found in several radiated animals. The time has come for its being established as a philosophical axiom that nerves are necessary for any degree of sensibility, the apparent exceptions being left as so many anomalies to be resolved by the future progress of anatomical analysis.

Sensibility.

Irritability.

The same process must be instituted with the common notions of irritability, which are still ruled by Bichat's theory. He supposed, for instance, that the contractions of the heart were determined, independently of all nervous action, by the immediate stimulus of the flow of the blood toward it; whereas, it is now established that a provision of nerves is as indispensable to the irritability of this muscle as of any other; and generally, that the great distinction laid down by Bichat, between organic and animal contractility, must be abandoned. All irritability is then necessarily animal; that is, it requires a corresponding nervous provision, whatever may be the immediate centre from which the nervous action proceeds. Much illustration of this subject is needed for its scientific use, though not for the logical sanction of a principle already placed beyond dispute. We need this further enlightenment, not only in regard to the use of the modern distinction made by many physiologists between the sensory and the motory nerves, though such a question has considerable philosophical importance; but much more in regard to another consideration, more direct and more eminent, in regard to which we are in a state of most inconvenient uncertainty and obscurity: I mean the scientific distinction which must be maintained, sooner or later, between the voluntary and involuntary motions. The doctrine of Bichat had the advantage of representing this difference, which we see, in fact, to have furnished him with his chief arguments; whereas, now that we insist on irritability being of one kind only. and dependent on a nervous provision, we find ourselves involved in a very delicate fundamental difficulty, the solution of which is however indispensable, to enable us to understand how all motions must not be indistinctly voluntary. For this solution we must obtain—what we certainly have not as yet—an exact co-ordination of anatomical differences with incontestable physiological differences. There can be no question that such a phenomenon as the voluntary movements of the locomotive muscles while that of the cardiac muscle remains absolutely involuntary, must admit of analysis, however difficult it may be. Here then we find a chasm among the very principles of the science, by which the positive theory of irritability is much perplexed, certain as is its principle. In almost all cases the ablest anatomist is unable to decide otherwise than by the fact itself, if any definite motion is necessarily voluntary or involuntary; which affords sufficient proof of the absence of any real law in the case. The solution will probably be obtained by an analysis of the intermediate motions, as we may call them,—those which, involuntary at first, end in becoming voluntary; or the reverse. These cases, which are very common, appear to me eminently fit to prove that the distinction between voluntary and involuntary motions arises from no radical difference of muscular irritability, but only from the mode, and perhaps the degree of innervation, modified by long habit. If this be as generally true as it seems to be in some cases of acquired control, it must be supposed that the most involuntary motions, which are those most indispensable to life, would have been susceptible of voluntary suspension (not even excepting the motions of the heart) if their incessant rigorous necessity had not hindered the contraction of suitable habits in their case. While we conclude it to be probable that the difference between the two kinds of motion proceeds indirectly from the action of the entire nervous system upon the muscular system, we can not help perceiving how greatly science stands in need of a thorough new examination into this obscure fact.

Present state of analysis of animality.

This brief survey shows us the general imperfection of the study of animality. We shall find that even in the department of the primitive analysis of its general phenomena, in which it appears so superior to that of the organic life, it is very far indeed from being yet fit for exploration by positive laws.

Movement.

In regard to irritability, first,—the mechanism of no animal movement has yet been satisfactorily analyzed, —all the chief cases being still the subject of radical controversy among equally-qualified physiologists. We retain a vicious distinction among movements, contrary to all mechanical judgment,—a distinction between the general motion which displaces the whole mass, and the partial motions which subserve the organic life,—as for the reception of aliment, or the expulsion of any residuum, or the circulation of fluids; yet the first order are partial, though their object is unlike that of the second; for, in a mechanical view, the organism allows of no others. By the great laws of motion, the animal can never displace its centre of gravity by interior motion, without co-operation from its environment, any more than a steam-carriage which should work without friction on a horizontal plane, turning its wheels without result. The movements which produce locomotion are not mechanically different from those, for instance, which carry food along the alimentary canal;—the difference is in the apparatus, which, for locomotion, consists of exterior appendages, so disposed, as to cause a reaction in the medium, which produces the displacement of the whole body. Certain mollusks furnish an illustration of this, when they change their place by means of contractions of the cardiac muscle, or of intestinal muscles. The simplest notions of animal mechanics being thus obscured and corrupted in their origin, it is no wonder that the physiologists still dispute about the mechanism of the circulation, and most of the means of locomotion, as leaping, flying, swimming, etc. In the way in which they proceed, they are remote from any mutual understanding, and the most opposite opinions may be maintained with equal plausibility. It needs but a word to suggest to those who have attended to what has gone before, that this extreme imperfection results from the inadequate and faulty education of physiologists, who are too often ignorant of the inorganic science which is here directly involved. The complexity of the animal apparatus, and the impossibility of bringing the primitive moving powers under any mathematical theory, will for ever forbid the application of numerical methods: but the great laws of equilibrium and motion are applicable, through all varieties of apparatus, and are the same in animal mechanics, or celestial, or industrial, or any other mechanics whatever. Some physiologists, finding their difficulty, have handed over their study to the geometers and physicists: and these, with their habits of numerical precision, and their ignorance of anatomy, have brought out only absurd results. The remedy is, as we know, in the work being consigned to physiologists, duly prepared by a sufficient training in inorganic science. The study of animal sounds, or phonation, for instance, can not be carried on to any purpose without such knowledge as physicists have of the theory of sound; and the general production of the voice, and the differences of utterance among animals, require for their explanation a knowledge at once of acoustics and anatomy; and speech itself requires this preparation no less, while demanding other requisites with it. It is to be hoped that all experience, in each department of scientific inquiry, will convince students more and more of the folly and mischief of the anarchical parcelling out of natural philosophy; but the physiologists are those who, above all, must see the need of a better organization of scientific labor,—so remarkable as is the subordination of their particular science to all that have gone before.

The analysis of the phenomena of sensibility is not more satisfactory than that of irritability: and even less so, if we leave out of the account the great knowledge that we have obtained, by anatomical study, of the corresponding organs; a knowledge which, however, must here be connected with physiology. The least imperfect part of this study relates to the simple exterior sensations. The phenomenon of sensation is composed of three elements, as we have seen: the impression of the external agent or the nervous extremities, by the aid of some physical apparatus; the transmission by the nervous fibre; and the reception by the cerebral organ. The first of these suggests, like the mechanical facts we have been considering, the immediate dependence of the phenomenon on the laws of the inorganic world; as the relation of the theory of vision to optics; of the theory of hearing to acoustics, in all that concerns the mode of action proper to the apparatus of sight and hearing. And yet, more expressly than even in the case of mechanics, have these theories been delivered into the hands of the physicists, who, again, bring out results from their treatment of them which are manifestly absurd. The only difference between this case and the preceding is that the metaphysicians have kept a longer hold upon this part of animal physiology,—the theory of sensations having been abandoned to them till a very recent time. It was not indeed till Gall imparted his ever-memorable impulse to the investigation, that physiologists claimed this department at all. It is no wonder, therefore, that the positive theory of sensations is less well conceived, and more recent than that of motion: and naturally more imperfect, independently of its superior difficulty, and the backwardness of those branches of physics to which it relates. The simplest modifications of the phenomenon of vision and of hearing can not as yet be referred with certainty to determinate organic conditions; as, for instance, the adjustment of the eye to see distinctly at very various distances; a faculty which the physiologists have allowed the physicists to attribute to various circumstances of structure, always illusory or inadequate, the physiologists the while playing the part of critics, instead of appropriating a study which belongs exclusively to them. Even the limits of the function are usually very vaguely defined: that is, the kind of exterior notions furnished by each sense, abstracted from all intellectual reflection, is rarely circumscribed with any distinctness. Thus it is no wonder if we are still ignorant of almost all positive laws of sight and hearing, and even of smell and taste.—The only point of doctrine, or rather of method, that we may consider to have attained any scientific stability, is the fundamental order in which the different kinds of sensations should be studied: and this notion has been supplied by comparative anatomy rather than by physiology. It consists in classifying the senses by their increasing speciality,—beginning with the universal sense of contact, or touch, and proceeding by degrees to the four special senses, taste, smell, sight, and finally, hearing. This order is rationally determined by the analysis of the animal series, as the senses must be considered more special and of a higher kind in proportion as

Exterior sensation

they disappear from the lower degrees of the zoological scale. It is remarkable that this gradation coincides with the degree of importance of the sensation in regard to sociality, if not to intelligence. Unhappily, it measures yet more evidently the increasing imperfection of the theory.—We ought not to pass over the luminous distinction introduced by Gall between the passive and the active state of each special sense. An analogous consideration to this, but more fundamental, would consist, it seems to me, in distinguishing the senses themselves as active and passive, according as their action is, from their nature, voluntary or involuntary. This distinction seems very marked in the case of sight and hearing; the one requiring our free participation, to a certain extent, while the other affects us without our will, or even our consciousness. The more vague, but more profound influence that music exercies over us, than we receive from painting, seems to be chiefly attributable to such a diversity. An analogous difference, but less marked, exists between taste and smell.

Interior sensation.

There is a second class of sensations, forming the natural transition from the study of the sensations to that of the affective and intellectual functions, which all physiologists, since the time of Cabanis, and yet more, of Gall, have found it necessary to admit, to complete the study of the sensations. They are the interior sensations which relate to the satisfaction of the natural wants; and, in a pathological state, the pains produced by bodily alteration. These are still more indispensable than the first to the perfection of the organic life; and, though they procure no direct notions of the external world, they radically modify, by their intense and continuous action, the general course of intellectual operations, which are, in most animal species, entirely subordinated to them. This great department of the theory of sensations is even more obscure and unadvanced than the foregoing. The only positive notion which is fairly established in regard to it is that the nervous system is indispensable to both kinds of sensibility.

Once again we see how the extreme imperfection of doctrine here is owing to the imperfection of method; and that again, as before, to the inadequate preparation of the inquirers to whom the study belongs. It is a great thing, however, to have withdrawn the subject from the control of the metaphysicians; and some labors of contemporary physiologists authorize us to hope that the true spirit of the inquiry is at length entered into; and that the study of the sensations will be directed, as it ought to be, to develop the radical accordance between anatomical and physiological analysis.

Mode of action of animality.

Having reviewed the two orders of animal functions, we must consider the complementary part of the theory of animality;—the ideas about the mode of action which are common to the phenomena of irritability and sensibility. It is true, these ideas belong also to intellectual and moral phenomena: but we must review them here, to complete our delineation of the chief aspects of the study of animal life.

The considerations about such mode of action naturally divide themselves into two classes; the one relating to the function of either motion or sensation, separately; and the other to the association of the two functions. The first may relate to either the mode or the degree of the animal phenomenon. Following this order, the first theory that presents itself is that of the intermittence of action, and consequently, that of habit, which results from it. Bichat was the first who pointed out the intermittent character of every animal faculty, in contrast with the continuousness of vegetative phenomena. The double movement of absorption and exhalation which constitutes life could not be suspended for a moment without determining the tendency to disorganization: whereas, every act of irritability or sensibility is necessarily intermittent, as no contraction or sensation can be conceived of as indefinitely prolonged; so that continuity would imply as great a contradiction in animal life as interruption in the organic. All the progress made, during the present century, in physiological anatomy, has contributed to the perfecting of this theory of intermittence. Rationally understood, it applies immediately to a very extensive and important class of animal phenomena: that is, to those which belong to the different degrees of sleep.

Intermittence.

Sleep.

The state of sleep thus consists of the simultaneous suspension, for a certain time, of the principal actions of irritability and sensibility. It is as complete as the organization of the superior animals admits when it suspends all motions and sensations but such as are indispensable to organic life,—their activity being also remarkably diminished. The phenomenon admits of great variety of degrees, from simple somnolence to the torpor of hybernating animals. But this theory of sleep, so well instituted by Bichat, is still merely initiated, and presents many fundamental difficulties, when we consider the chief modifications of such a state, even the organic conditions of which are very imperfectly known, except the stagnation of the venous blood in the brain, which appears to be generally an indispensable preliminary to all extended and durable lethargy. It is easy to conceive how the prolonged activity of the animal functions in a waking state may, by the law of intermittence, occasion a proportional suspension: but it is not so easy to see why the suspension should be total when the activity has been only partial. Yet we see how profound is the sleep, intellectual and muscular, induced by fatigue of the muscles alone in men who, while awake, have given very little exercise to their sensibility, interior, or even exterior. We know still less of incomplete sleep; especially when only a part of the intellectual or affective organs, or of the locomotive apparatus is torpid; whence arise dreams and various kinds of somnambulism. Yet such a state has certainly its own general laws, as well as the waking state. Some experiments, not duly attended to, perhaps justify the idea that, in animals, in which the cerebral life is much less varied, the nature of dreams becomes, to a certain point, susceptible of being directed at the pleasure of the observer, by the aid of external impressions produced, during sleep, upon the senses whose action is involuntary; and especially smell. And in the case of Man, there is no thoughtful physician who, in certain diseases, does not take into the account the habitual character of the patient's dreams, in order to perfect the diagnosis of maladies in which the nervous system is especially implicated: and this supposes that the state is subject to determinate laws, though they may be unknown. But, however imperfect the theory of sleep may still be, in these essential respects, it is fairly constituted upon a positive basis of its own; for, looked at as a whole, it is *explained*, according to the scientific acceptation of the term, by its radical identity with the phenomena of partial repose offered by all the elementary acts of the animal life. When the theory of intermittence is perfected, we shall, I imagine, adopt Gall's view of connecting it with the symmetry which characterizes all the organs of animal life, by regarding the two parts of the symmetrical apparatus as alternately active and passive, so that their function is never simultaneous: and this, as much in regard to the external senses as the intellectual organs. All this, however, deserves a fresh and thorough investigation.

Habit.

The theory of Habit is a sort of necessary appendix to that of intermittence; and, like it, due to Bichat. A continuous phenomenon would be, in fact, capable of persistence, in virtue of the law of inertia; but intermittent phenomena alone can give rise to habits, properly so called: that is, can tend to reproduce themselves spontaneously through the influence of a preliminary repetition, sufficiently prolonged at suitable intervals. The importance of this animal property is now universally acknowledged among able inquirers, who see in it one of the chief bases of the gradual perfectibility of animals, and especially of Man. Through this it is that vital phenomena may, in some sort, participate in the admirable regularity of those of the inorganic world, by becoming, like them, periodical, notwithstanding their greater complexity. Thence also results the transformation—optional up to a certain point of inveteracy of habit, and inevitable beyond that point—of voluntary acts into involuntary tendencies. But the study of habit is no further advanced than that of intermittence, in regard to its analysis: for we have paid more attention hitherto to the influence of habits once contracted than to their origin, with regard to which scarcely any scientific doctrine exists. What is known lies in the department of natural history, and not in that of biology. Perhaps it may be found, in the course of scientific study, that we have been too hasty in calling this an animal property, though the animal structure may be more susceptible of it. In fact, there is no doubt that inorganic apparatus admits of a more easy reproduction of the same acts after a sufficient regular and prolonged reiteration, as I had occasion to observe in regard to the phenomenon of sound: and this is essentially the character of animal habit. According to this view, which I commend to the attention of biologists, and which, if true, would constitute the most general point of view on this subject, the law of habit may be scientifically attached to the law of inertia, as geometers understand it in the positive theory of motion and equilibrium.

In examining the phenomena common to irritability and sensibility under the aspect of their activity, physiologists have to examine the two extreme terms,—exaggerated action, and insufficient action, in order to determine the intermediate normal degree: for the study of intermediate cases can never be successfully undertaken till the extreme cases which comprehend them have been first examined.

Need of activity

The need of exercising the faculties is certainly the most general and important of all those that belong to the animal life: we may even say that it comprehends them all, if we exclude what relates merely to the organic life. The existence of an animal organ is enough to awaken the need immediately. We shall see, in another chapter, that this consideration is one of the chief bases that social physics derives from individual physiology. Unhappily this study is still very imperfect with regard to most of the animal functions, and to all the three degrees of their activity. To it we must refer the analysis of all the varied phenomena of pleasure and pain, physical and moral. The case of defect has been even less studied than that of excess; and yet its scientific examination is certainly not less important, on account of the theory of *ennui*, the consideration of which is so prominent in social physics,—not only in connection with an advanced state of civilization, but even in the roughest periods, in which, as we shall see hereafter, *ennui* is one of the chief moving springs of social evolution. As for the intermediate degree, which characterizes health, welfare, and finally happiness, it can not be well treated till the extremes are better understood. The only positive principle yet established in this part of physiology is that which prescribes that we should not contemplate this normal degree in an absolute manner, but in subordination to the intrinsic energy of the corresponding faculties; as popular good sense has already admitted, however difficult it may be practically to conform to the precept in social matters, from the unreflecting tendency of every man to erect himself into a necessary type of the whole species.

We have now only to notice, further, the third order of considerations; the study of the association of the animal functions.

Association of the animal functions.

This great subject should be divided into two parts, relating to the *sympathies*, to which Bichat has sufficiently drawn the attention of physiologists, and the *synergies*, as Barthez has called them, which are at present too much neglected. The difference between these two sorts of vital association corresponds to that between the normal and the pathological states: for there is synergy whenever two organs concur simultaneously in the regular accomplishment of any function; whereas sympathy supposes a certain perturbation, momentary or permanent, partial or general, which has to be stopped by the intervention of an organ not primarily affected. These two modes of physiological association are proper to the animal life, any appearance to the contrary being due to the influence of animal over organic action. The study is fairly established on a rational basis; the physiologists of our time seeming to be all agreed as to the nervous system being the necessary agent of all sympathy; and this is enough for the foundation of a positive theory. Beyond this, we have only disjointed though numerous facts. The study of the synergies, though more simple and better circumscribed, does not present, as yet, a more satisfactory scientific character, either as to the mutual association of the different motions, or as to the different modes of sensibility; or as to the more general and complex association between the phenomena of sensibility and those of irritability. And yet this great subject leads directly to the most important theory that physiology can finally present,—that of the fundamental unity of the animal organism, as a necessary result of a harmony between its various chief functions. Here alone it is that, taking each elementary faculty in its normal state, we can find the sound theory of the *Ego*, so absurdly perverted at present by the vain dreams of the metaphysicians: for the general sense of the *I* is certainly determined by the equilibrium of the faculties, the disturbance of which impairs that consciousness so profoundly in other diseases.

CHAPTER VI.

INTELLECTUAL AND MORAL, OR CEREBRAL FUNCTIONS.

THE remaining portion of biological philosophy is that which relates to the study of the affective and intellectual faculties, which leads us over from individual physiology to Social Physics, as vegetative physiology does from the inorganic to the organic philosophy.

Shortcoming of Descartes.

While Descartes was rendering to the world the glorious service of instituting a complete system of positive philosophy, the reformer, with all his bold energy, was unable to raise himself so far above his age as to give its complete logical extension to his own theory by comprehending in it the part of physiology that relates to intellectual and moral phenomena. After having instituted a vast mechanical hypothesis upon the fundamental theory of the most simple and universal phenomena, he extended in succession the same philosophical spirit to the different elementary notions relating to the inorganic world; and finally subordinated to it the study of the chief physical functions of the animal organism. But, when he arrived at the functions of the affections and the intellect, he stopped abruptly, and expressly constituted from them a special study, as an appurtenance of the metaphysico-theological philosophy, to which he thus endeavored to give a kind of new life, after having wrought far more successfully in sapping its scientific foundations. We have an unquestionable evidence of the state of his mind in his celebrated paradox about the intelligence and instincts of animals. He called brutes automata, rather than allow the application of the old philosophy to them. Being unable to pursue this method with Man, he delivered him over expressly to the domain of metaphysics and theology. It is difficult to see how he could have done otherwise, in the then existing state of knowledge: and we owe to his strange hypothesis, which the physiologists went to work to confute, the clearing away of the partition which he set up between the study of animals and that of Man, and consequently, the entire elimination among the higher order of investigators, of theological and metaphysical philosophy. What the first contradictory constitution of the modern philosophy was, we may see in the great work of Malebranche, who was the chief interpreter of Descartes, and who shows how his philosophy continued to apply to the most complex parts of the intellectual system the same methods which had been shown to be necessarily futile with regard to the simplest subjects. It is necessary to indicate this state of things because it has remained essentially unaltered during the last two centuries, notwithstanding the vast progress of positive science, which has all the while been gradually preparing for its inevitable transformation. The school of Boerhaave left Descartes's division of subjects as they found it: and if they, the successors of Descartes in physiology, abandoned this department of it to the metaphysical method, it can be no wonder that intellectual and moral phenomena remained, till this century, entirely excluded from the great scientific movement originated and guided by the impulse of Descartes. The growing action of the positive spirit has been, during the whole succeeding interval, merely critical—attacking the inefficacy of metaphysical studies—exhibiting the perpetual reconciliation of the naturalists on points of genuine doctrine, in contrast to the incessant disputes of various metaphysicians, arguing still, as from Plato downward, about the very elements of their pretended science: this criticism itself relating only to results, and still offering no objection to the supremacy of metaphysical philosophy, in the study of Man, in his intellectual and moral aspects. It was not till our own time that modern science, with the illustrious Gall for its organ, drove the old philosophy from this last portion of its domain, and passed on in the inevitable course from the critical to the organic state, striving in its turn to treat in its own way the general theory of the highest vital functions. However imperfect the first attempts, the thing is done. Subjected for half a century to the most decisive tests, this new doctrine has clearly manifested all the indications which can guaranty the indestructible vitality of scientific

History till Gall's time.

conceptions. Neither enmity nor irrational advocacy has hindered the continuous spread, in all parts of the scientific world, of the new system of investigation of intellectual and moral man. All the signs of the progressive success of a happy philosophical revolution are present in this case.

Positive theory of Cerebral functions.

The positive theory of the affective and intellectual functions is therefore settled, irreversibly, to be this: it consists in the experimental and rational study of the phenomena of interior sensibility proper to the cerebral ganglions, apart from all immediate external apparatus. These phenomena are the most complex and the most special of all belonging to physiology; and therefore they have naturally been the last to attain to a positive analysis; to say nothing of their relation to social considerations, which must be an impediment in the way of their study. This study could not precede the principal scientific conceptions of the organic life, or the first notions of the animal life; so that Gall must follow Bichat: and our surprise would be that he followed him so soon, if the maturity of his task did not explain it sufficiently. The grounds of my provisional separation of this part of physiology from the province of animal life generally are—the eminent differences between this order of phenomena and those that have gone before—their more direct and striking importance—and, above all, the greater imperfection of our present study of them. This new body of doctrine, thus erected into a third section of physiology, will assume its true place within the boundaries of the second when we obtain a distincter knowledge of organic, and a more philosophical conception of animal physiology. We must bear in mind what the proper arrangement should be—this third department differing much less from the second than the second differs from the first.

Its proper place.

Vices of Psychological systems.

We need not stop to draw out any parallel or contrast between phrenology and psychology. Gall has fully and clearly exposed the powerlessness of metaphysical methods for the study of intellectual and moral phenomena: and in the present state of the human mind, all discussion on this subject is superfluous. The great philosophical cause is tried and judged; and the metaphysicians have passed from a state of domination to one of protestation—in the learned world at least, where their opposition would obtain no attention but for the inconvenience of their still impeding the progress of popular reason. The triumph of the positive method is so decided that it is needless to devote time and effort to any demonstration, except in the way of instruction; but, in order to characterize, by a striking contrast, the true general spirit of phrenological physiology, it may be useful here to analyze very briefly the radical vices of the pretended psychological method, considered merely in regard to what it has in common in the principal existing schools;—in those called the French, the German, and (the least consistent and also the least absurd of the three) the Scotch school:—that is, as far as we can talk of schools in a philosophy which, by its nature, must engender as many incompatible opinions as it has adepts gifted with any degree of imagination. We may, moreover, refer confidently to these sects for the mutual refutation of their most essential points of difference.

Method. Interior Observation.

As for their fundamental principle of *interior observation*, it would certainly be superfluous to add anything to what I have already said about the absurdity of the supposition of a man seeing himself think. It was well remarked by M. Broussais, on this point, that such a method, if possible, would extremely restrict the study of the understanding, by necessarily limiting it to the case of adult and healthy Man, without any hope of illustrating this difficult doctrine by any comparison of different ages, or consideration of pathological states, which yet are unanimously recognised as indispensable auxiliaries in the simplest researches about Man. But, further, we must be also struck by the absolute interdict which is laid upon all intellectual and moral study of animals, from whom the psychologists can hardly be expecting any *interior observation.* It seems rather strange that the philosophers who have so attenuated this immense subject should be those who are for ever reproaching their adversaries with a want of comprehensiveness and elevation. The case of animals is the rock on which all psychological theories have split, since the naturalists have compelled the metaphysicians to part with the singular expedient imagined by Descartes, and to admit that animals, in the higher parts of the scale at least, manifest most of our affective, and even intellectual faculties, with mere differences of degree; a fact which no one at this day ventures to deny, and which is enough of itself to demonstrate the absurdity of these idle conceptions.

Recurring to the first ideas of philosophical common sense, it is at once evident that no function can be studied but with relation to the organ that fulfils it, or to the phenomena of its fulfilment: and, in the second place, that the affective functions, and yet more the intellectual, exhibit in the latter respect this particular characteristic,—that they can not be observed during their operation, but only in their results,—more or less immediate, and more or less durable. There are then only two ways of studying such an order of functions; either determining, with all attainable precision, the various organic conditions on which they depend,—which is the chief object of phrenological physiology; or in directly observing the series of intellectual and moral acts,—which belongs rather to natural history, properly so called: these two inseparable aspects of one subject being always so conceived as to throw light on each other. Thus regarded, this great study is seen to be indissolubly connected on the one hand with the whole of the foregoing parts of natural philosophy, and especially with the fundamental doctrines of biology; and, on the other hand, with the whole of history,—of animals as well as of man and of humanity. But when, by the pretended psychological method, the consideration of both the agent and the act is discarded altogether, what material can remain but an unintelligible conflict of words, in which merely nominal entities are substituted for real phenomena? The most difficult study of all is thus set up in a state of isolation, without any one point of support in the most simple and perfect sciences, over which it is yet proposed to give it a majestic sovereignty; and in this all psychologists agree, however extreme may be their differences on other points.

Doctrine. Relation between the Affective and Intellectual faculties.

About the method of psychology or ideology, enough has been said. As to the doctrine, the first glance shows a radical fault in it, common to all sects,—a false estimate of the general relations between the affective and the intellectual faculties. However various may be the theories about the preponderance of the latter, all metaphysicians assert that preponderance by making these faculties their starting-point. The intellect is almost exclusively the subject of their speculations, and the affections have been almost entirely neglected; and, moreover, always subordinated to the understanding. Now, such a conception represents precisely the reverse of the reality, not only for animals, but also for Man: for daily experience shows that the affections, the propensities, the passions, are the great springs of human life; and that, so far from resulting from intelligence, their spontaneous and independent impulse is indispensable to the first awakening and continuous development of the various intellectual faculties, by assigning to them a permanent end, without which—to say nothing of the vagueness of their general direction—they would remain dormant in the majority of men. It is even but too certain that the least noble and most animal propensities are habitually the most energetic, and therefore the most influential. The whole of human nature is thus very unfaithfully represented by these futile systems, which, if noticing the affective faculties at all, have vaguely connected them with one single principle, sympathy, and, above all, self-consciousness, always supposed to be directed by the intellect. Thus it is that, contrary to evidence, Man has been represented as essentially a reasoning being, continually carrying on, unconsciously, a multitude of imperceptible calculations, with scarcely any spontaneity of action, from infancy upward. This false conception has doubtless been supported by a consideration worthy of all respect,—that it is by the intellect that Man is modified and improved; but science requires, before all things, the reality of any views, independently of their desirableness; and it is always this reality which is the basis of genuine utility. Without denying the secondary influence of such a view, we can show that two purely philosophical causes, quite unconnected with any idea of application, and inherent in the nature of the method, have led the metaphysicians of all sects to this hypothesis of the supremacy of the intellect. The first is the radical separation which it was thought necessary to make between brutes and man, and which would have been af-

Brutes and Man.

fected at once by the admission of the preponderance of the affective over the intellectual faculties; and the second was the necessity that the metaphysicians found themselves under, of preserving the unity of what they called the *I*, that it might correspond with the unity of the *soul*, in obedience to the requisitions of the theological philosophy, of which metaphysics is, as we must ever bear in mind, the final transformation. But the positive philosophers, who approach the questions with the simple aim of ascertaining the true state of things, and reproducing it with all possible accuracy in their theories, have perceived that, according to universal experience, human nature is so far from being single that it is eminently multiple; that is, usually induced in various directions by distinct and independent powers, among which equilibrium is established with extreme difficulty when, as usually happens in civilized life, no one of them is, in itself, sufficiently marked to acquire spontaneously any considerable preponderance over the rest. Thus, the famous theory of the *I* is essentially without a scientific object, since it is destined to represent a purely fictitious state. There is, in this direction, as I have already pointed out, no other real subject of positive investigation than the study of equilibrium of the various animal functions,—both of irritability and of sensibility,—which marks the normal state, in which each of them, duly moderated, is regularly and permanently associated with the whole of the others, according to the laws of sympathy, and yet more of synergy. The very abstract and indirect notion of the *I* proceeds from the continuous sense of such a harmony; that is, from the universal accordance of the entire organism. Psychologists have attempted in vain to make out of this idea, or rather sense, an attribute of humanity exclusively. It is evidently a necessary result of all animal life; and therefore it must belong to all animals, whether they are able to discourse upon it or not. No doubt a cat, or any other vertebrated animal, without knowing how to say "I," is not in the habit of taking itself for another. Moreover, it is probable that among the superior animals the sense of personality is still more marked than in Man, on account of their more isolated life; though if we descended too far in the zoological scale we should reach organisms in which the continuous degradation of the nervous system attenuates this compound sense, together with the various simple feelings on which it depends.

Theory of the *I*.

It must not be overlooked that though the psychologists have agreed in neglecting the intellectual and moral faculties of brutes, which have been happily left to the naturalists, they have occasioned great mischief by their obscure and indefinite distinction between intelligence and instinct, thus setting up a division between human and animal nature which has had too much effect even upon zoologists to this day. The only meaning that can be attributed to the word *instinct*, is any spontaneous impulse in a determinate direction, independently of any foreign in-

Reason and Instinct.

fluence. In this primitive sense, the term evidently applies to the proper and direct activity of any faculty whatever, intellectual as well as affective: and it therefore does not conflict with the term *intelligence* in any way, as we so often see when we speak of those who, without any education, manifest a marked talent for music, painting, mathematics. etc. In this way there is instinct, or rather, there are instincts in Man, as much or more than in brutes. If, on the other hand, we describe *intelligence* as the aptitude to modify conduct in conformity to the circumstances of each case,—which, in fact, is the main practical attribute of *reason*, in its proper sense, —is is more evident than before that there is no other essential difference between humanity and animality than that of the degree of development admitted by a faculty which is, by its nature, common to all animal life, and without which it could not even be conceived to exist. Thus the famous scholastic definition of Man as a *reasonable animal* offers a real no-meaning, since no animal, especially in the higher parts of the zoological scale, could live without being to a certain extent reasonable, in proportion to the complexity of its organism. Though the moral nature of animals has been but little and very imperfectly explored, we can yet perceive, without possibility of mistake, among those that live with us and that are familiar with us,—judging of them by the same means of observation that we should employ about men whose language and ways were previously unknown to us,—that they not only apply their intelligence to the satisfaction of their organic wants, much as men do, aiding themselves also with some sort of language; but that they are, in like manner, susceptible of a kind of wants more disinterested, inasmuch as they consist in a need to exercise their faculties for the mere pleasure of the exercise. It is the same thing that leads children or savages to invent new sports, and that renders them, at the same time, liable to *ennui*. That state, erroneously set up as a special privilege of human nature, is sometimes sufficiently marked, in the case of certain animals, to urge them to suicide, when captivity has become intolerable. An attentive examination of the facts therefore discredits the perversion of the word *instinct* when it is used to signify the fatality under which animals are impelled to the mechanical performance of *acts* uniformly determinate, without any possible modification from corresponding circumstances, and neither requiring nor allowing any education, properly so called. This gratuitous supposition is evidently a remnant of the automatic hypothesis of Descartes. Leroy has demonstrated that among mammifers and birds this ideal fixity in the construction of habitations, in the seeking of food by hunting, in the mode of migration, etc., exist only in the eyes of closet-naturalists or inattentive observers.

After thus much notice of the radical vice of all psychological systems, it would be departing from the object of this work to show how the intellectual faculties themselves have been misconceived. It is enough to refer to the refutation by which Gall and

Spurzheim have introduced their labors: and I would particularly point out the philosophical demonstration by which they have exhibited the conclusion that sensation, memory, imagination, and even judgment—all the scholastic faculties, in short—are not, in fact, fundamental and abstract faculties, but only different degrees or consecutive modes of the same phenomenon, proper to each of the true elementary phrenological functions, and necessarily variable in different cases, with a proportionate activity. One virtue of this admirable analysis is that it deprives the various metaphysical theories of their one remaining credit—their mutual criticism, which is here effected, once for all, with more efficacy than by any one of the mutually opposing schools.

Again, it would be departing from the object of this portion of our work to judge of the doctrines of the schools by their results. What these have been we shall see in the next book; the deplorable influence on the political and social condition of two generations of the doctrines of the French school, as presented by Helvetius, and of the German psychology, with the ungovernable *I* for its subject; and the impotence of the Scotch school, through the vagueness of what is called its doctrines, and their want of mutual connection. Dismissing all these for the present, we must examine the great attempt of Gall, in order to see what is wanting in phrenological philosophy to form it into the scientific constitution which is proper to it, and from which it is necessarily still more remote than organic, and even animal physiology.

Basis of Gall's doctrine. Two philosophical principles, now admitted to be indisputable, serve as the immovable basis of Gall's doctrine as a whole: viz., the innateness of the fundamental dispositions, affective and intellectual, and the plurality of the distinct and independent faculties, though real acts usually require their more or less complex concurrence. Within the limits of the human race, all cases of marked talents or character prove the first; and the second is proved by the diversity of such marked cases, and by most pathological states—especially by those in which the nervous system is directly affected. A comparative observation of the higher animals would dispel all doubt, if any existed in either case. These two principles—aspects of a single fundamental conception—are but the scientific expression of the results of experience, in all times and places, as to the intellectual and moral nature of Man—an indispensable symptom of truth, with regard to all parent ideas, which must always be connected with the spontaneous indications of popular reason, as we have seen in preceding cases in natural philosophy. Thus besides all guidance from analogy, after the study of animal life, we derive confirmation from all the methods of investigation that physiology admits; from direct observation, experiment, pathological analysis, the comparative method, and popular good sense—all of which converge toward the establishment of this double principle. Such a collection of proofs secures the stability of this much of phrenological doctrine, whatever transformations other parts may have to undergo. In the anatomical view, this physiological conception corresponds with the division of the brain into a certain number of partial organs, symmetrical like those of the animal life, and, though more contiguous and mutually resembling than in any other system, and therefore more adapted both for sympathy and synergy, still distinct and mutually independent, as we were already aware was the case with the ganglions appropriate to the external senses. In brief, the brain is no longer an organ, but an apparatus of organs, more complex in proportion to the degree of animality. The proper object of phrenological physiology thence consists in determining the cerebral organ appropriate to each clearly-marked, simple disposition, affective or intellectual; or, reciprocally, which is more difficult, what function is fulfilled by any portion of the mass of the brain which exhibits the anatomical conditions of a distinct organ. The two processes are directed to develop the agreement between physiological and anatomical analysis which constitutes the true science of living beings. Unfortunately, our means are yet further from answering our aims than in the two preceding divisions of the science.

Divisions of the brain.

The scientific principle involved in the phrenological view is that the functions, affective and intellectual, are more elevated, more human, if you will, and at the same time less energetic, in proportion to the exclusiveness with which they belong to the higher part of the zoological series, their positions being in portions of the brain more and more restricted in extent, and further removed from its immediate origin,—according to the anatomical decision that the skull is simply a prolongation of the vertebral column, which is the primitive centre of the nervous system. Thus, the least developed and anterior part of the brain is appropriated to the characteristic faculties of humanity; and the most voluminous and hindmost part to those which constitute the basis of the whole of the animal kingdom. Here we have a new and confirmatory instance of the rule which we have had to follow in every science; that it is necessary to proceed from the most general to the more special attributes, in the order of their diminishing generality. We shall meet with it again in the one science which remains for us to review; and its constant presence, through the whole range, points it out as the first law of the dogmatic procedure of the positive spirit.

A full contemplation of Gall's doctrine convinces us of its faithful representation of the intellectual and moral nature of Man and animals. All the psychological sects have misconceived or ignored the pre-eminence of the affective faculties, plainly manifest as it is in all the moral phenomena of brutes, and even of Man; but we find this fact placed on a scientific basis by the discovery that the affective organs occupy all the hinder and middle portions of the cerebral apparatus, while the intellectual occupy only the front portion, which, in extreme cases, is not more than a fourth, or even a sixth part of the whole. The difference between Gall and his predecessors was not in the separation of the two kinds of faculties, but that they assigned the brain to the intellectual faculties alone, regarding it as a single organ, and distributing the passions among the organs pertaining to the vegetative life,—the heart, the liver, etc. Bichat supported this view by the argument of the sympathies of these organs, under the excitement of the respective passions; but the variableness of the seat of sympathy, according to native susceptibility or to accident, is a sufficient answer to such a plea, and teaches us simply the importance of considering the influence exercised by the state of the brain upon the nerves which supply the apparatus of the organic life.

Subdivisions.

Next comes the subdivison established by Gall and Spurzheim in each of these two orders. The affective faculties are divided into the propensities, and the affections or sentiments: the first residing in the hindmost and lowest part of the brain; and the other class in the middle portion. The intellectual faculties are divided into the various perceptive faculties, which together constitute the range of observation: and the small number of reflective faculties, the highest of all, constituting the power of combination, by comparison and co-ordination. The upper part of the frontal region is the seat of these last, which are the chief characteristic attribute of human nature. There is a certain deficiency of precision in this description; but, besides that we may expect improving knowledge to clear it up, we shall find, on close examination, that the inconvenience lies more in the language than in the idea. The only language we have is derived from a philosophical period when all moral and even intellectual ideas were shrouded in a mysterious metaphysical unity, which allows us now no adequate choice of terms.

Taking the ordinary terms in their literal sense, we should misconceive the fundamental distinction between the intellectual faculties and the others. When the former are very marked, they unquestionably produce real inclinations or propensities, which are distinguished from the inferior passions only by their smaller energy. Nor can we deny that their action occasions true emotions or sentiments, more rare, more pure, more sublime than any other, and, though less vivid than others, capable of moving to tears; as is testified by so many instances of the rapture excited by the discovery of truth, in the most eminent thinkers that have done honor to their race—as Archimedes, Descartes, Kepler, Newton, etc. Would any thoughtful student take occasion, by such approximations, to deny all real distinction between the intellectual and affective faculties? The wiser conclusion to be drawn from the case is that we must reform our philosophical language, to raise it, by rigorous precision, to the dignity of scientific language. We may say as much about the subdivision of the affective faculties into propensities and sentiments, the distinction being, though less marked, by no means less real. Apart from all useless discussion of nomenclature, we may say that the real difference has not been clearly seized. In a scientific view, it would suffice to say that the first and fundamental class relates to the individual alone, or, at most, to the family, regarded successively in its principal needs of preservation,—such as reproduction, the rearing of young, the mode of alimentation, of habitation, etc. Whereas, the second more special class supposes the existence of some social relations, either among individuals of a different species, or especially between individuals of the same species, apart from sex, and determines the character which the tendencies of the animal must impress on each of these relations, whether transient or permanent. If we keep this distinctive character of the two classes in view, it will matter little what terms we use to indicate them, when once they shall have acquired a sufficient fixedness, through rational use.

There are the great philosophical results of Gall's doctrine, regarded, as I have now presented it, apart from all vain attempts to localize in a special manner the cerebral or phrenological functions. I shall have to show how such an attempt was imposed upon Gall by the necessities of his glorious mission: but notwithstanding this unfortunate necessity, the doctrine embodies already a real knowledge of human and brute nature vary far superior to all that had ever been offered before.

Objections. Necessity of human actions.

Among the innumerable objections which have been aimed at this fine doctrine,—considered always as a whole, the only one which merits discussion here is the supposed necessity of human actions. This objection is not only of high importance in itself, but it casts new light back upon the spirit of the theory; and we must briefly examine it from the point of view of positive philosophy.

Answered.

When objectors confound the subjection of events to invariable laws with their necessary exemption from modification, they lose sight of the fact that phenomena become susceptible of modification in proportion to their complexity. The only irresistible action that we know of is that of weight, which takes place under the most general and simple of all natural laws. But the phenomena of life and acts of the mind are so highly complex as to admit of modification beyond all estimate; and in the intermediate regions, phenomena are under control precisely in the order of their complexity. Gall and Spurzheim have shown how human action depends on the combined operation of several faculties; how exercise develops them; how inactivity wastes them; and how the intellectual faculties, adapted to modify the general conduct of the animal according to the variable exigencies of his situation, may overrule the practical influence of all his other faculties. It is only in mania, when disease interferes with the natural action of the faculties, that fatality, or what is popularly called irresponsibility, exists. It is therefore a great mistake to accuse cerebral physiology of disowning the influence of education or legislation, because it fixes the limits of their power. It denies the possibility, asserted by the ideology of the French school, of converting by suitable arrangements, all men into so many Socrates, Homers, or Archimedes; and it denies the ungovernable energy of the *I*, asserted by the German school; but it does not therefore affect Man's reasonable liberty, or interfere with his improvement by the aid of a wise education. It is evident indeed that improvement by education supposes the existence of requisite predispositions: and that each of them is subject to determinate laws, without which they could not be systematically influenced; so that it is, after all, cerebral physiology that is in possession of the philosophical problem of education. Furthermore, this physiology shows us that men are commonly of an average constitution; that is, that, apart from a very few exceptional organizations, every one possesses in a moderate degree all the propensities, all the sentiments, and all the elementary aptitudes, without any one faculty being remarkably preponderant. The widest field is thus open for education, in modifying in almost any direction organisms so flexible, though the degree of their development may remain of that average amount which consists very well with social harmony; as we shall have occasion to see hereafter.

Hypothetical distribution of faculties.

A much more serious objection to Gall's doctrine arises out of the venturesome and largely erroneous localization of the faculties which he thought proper to propose. If we look at his position, we shall see that he merely used the right, common to all natural philosophers, of instituting a scientific hypothesis, in accordance with the theory on that subject which we examined in connection with physics. He fulfilled the conditions of this theory; his subject being, not any imaginary fluids, ethers, or the like, but tangible organs, whose hypothetical attributes admit of positive verifications. Moreover, none of those who have criticised his localization could have proposed any less imperfect, or, probably, so well indicated. The advice of prudent mediocrity, to abstain from hypothesis, is very easy to offer; but if the advice was followed, nothing would ever be done in the way of scientific discovery. It is doubtless inconvenient to have to withdraw or remake, at a subsequent period, the hypotheses to which a science owes its existence, and which, by that time, have been adopted by inferior inquirers with a blinder and stronger faith than that of the original proposers: but there is no use in dwelling upon a liability which arises from the infirmity of our intelligence. The practical point for the future is that strong minds, prepared by a suitable scientific education, should plant themselves on the two great principles which have been laid down as the foundation of the science, and thence explore the principal needs of cerebral physiology, and the character of the means by which it may be carried forward. Nor need there be any fear that the science will be held back by such a method. Nothing prevents us, when reasoning, as geometers do, upon indeterminate seats, or positions supposed to be indeterminate, from arriving at real conclusions, involving actual utility, as I hope to show, from my own experience, in future chapters; though it is evident that it will be a great advantage to the exactness and efficacy of our conclusions, whenever the time arrives for the positive determination of the cerebral organs. Meantime, it is clear that we owe to Gall's hypothetical localization our view of the necessity of such a course; and that if he had confined himself to the high philosophical generalities with which he has furnished us, he would never have constituted a science, nor formed a school; and the truths which we see to be inestimable would have been strangled in their birth by a coalition of hostile influences.

Needed improvements.

We see what is the philosophical character of cerebral physiology. We must next inquire what are the indispensable improvements that it demands.

Anatomical basis.

First, we want a fundamental rectification of all the organs and faculties, as a necessary basis for all further progress. Taking an anatomical view of this matter, we see that the distribution of organs has been directed by physiological analyses alone,—usually imperfect and superficial enough,—instead of being subjected to anatomical determinations. This has entitled all anatomists to treat such a distribution as arbitrary and loose, because, being subject to no anatomical consideration about the difference between an organ and a part of an organ, it admits of indefinite subdivisions, which each phrenologist seems to be able to multiply at will. Though the analysis of functions no doubt casts much light on that of organs, the original decomposition of the whole organism into systems of organs, and those again into single organs, is not the less independent of physiological analysis, to which, on the contrary, it must furnish a basis. This is established in regard to all other biological studies; and there is no reason why cerebral inquiries should be an exception. We do not need to see the digestive or the respiratory apparatus in action, before anatomy can distinguish them from each other: and why should it be otherwise with the cerebral apparatus? The anatomical difficulties are no doubt much greater, on account of the resemblance and proximity of the organs in the cerebral case: but we must not give up this indispensable analysis for such a reason as that. If it were so, we must despair of conferring a special scientific character on phrenological doctrine at all; and we must abide by those generalities alone which I have just laid down. When we propose to develop the harmony between the anatomical and the physiological analysis of any case, it is supposed that each has been separately established, and not that the one can be copied from the other. Nothing, therefore, can absolve the phrenologists from the obligation to pursue the analysis of the cerebral system by a series of vigorous anatomical labors, discarding for the time all ideas of function, or, at most, employing them only as auxiliary to anatomical exploration. Such a consideration will be most earnestly supported by those phrenologists who perceive that, in determining the relative preponderance of each cerebral organ in different subjects, it is not only the bulk and weight of the organ that has to be taken into the account, but also its degree of activity, anatomically estimated, by, for instance, the energy of its partial circulation.

Physiological analysis of faculties.

Next, following a distinct but parallel order of ideas, there must be a purely physiological analysis of the various elementary faculties; and in this analysis, which has to be harmonized with the other, every anatomical idea must be, in its turn, discarded. The position of phrenology is scarcely more satisfactory in this view than any other, for the distinction between the different faculties, intellectual and even affective, and their enumeration, are conceived of in a very superficial way, though incomparably more in the positive spirit than any metaphysical analyses. If metaphysicians have confounded all their psychological notions in an absurd unity, it is probable that the phrenologists have gone to the other extreme in multiplying elementary functions. Gall set up twenty-seven; which was, no doubt, an exaggeration to begin with. Spurzheim raised the number to thirty-five; and it is liable to daily increase for want of a rational principle of circumscription for the regulation of the easy enthusiasm of popular explorers. Unless a sound philosophy interposes, to establish some order, we may have as many faculties and organs as the psychologists of old made entities. However great may be the diversity of animal natures, or even of human types, it is yet to be conceived (as real acts usually suppose the concurrence of several fundamental faculties) that even a greater multiplicity might be represented by a very small number of elementary functions of the two orders. If, for instance, the whole number were reduced to twelve or fifteen well-marked faculties, their combinations, binary, ternary, quaternary, etc., would doubtless correspond to many more types than can exist, even if we restricted ourselves to distinguishing, in relation to the normal degree of activity of each function, two other degrees—one higher and the other lower. But the exorbitant multiplication of faculties is not in itself so shocking as the levity of most of the pretended analyses which have regulated their distribution. In the intellectual order, especially, the aptitudes have been usually ill-described, apart from the organs: as when a mathematical aptitude is assigned on grounds which would justify our assigning a chemical aptitude, or an anatomical aptitude, if the whole bony casket had not been previously parcelled off into irremoveable compartments. If a man could do sums according to rules quickly and easily, he had the mathematical aptitude, according to those who do not suspect that mathematical speculations require any superiority of intellect. Though the analysis of the affective faculties, which are so much better marked, is less imperfect, there are several instances of needless multiplication in that department.

Examination of historical cases.

To rectify or improve this analysis of the cerebral faculties, it would be useful to add to the observation of Man and society a physiological estimate of the most marked individual cases,—especially in past times. The intellectual order, which most needs revision, is that which best admits of this procedure. If, for instance, it had been applied to the cases of the chief geometers, the absurd mistake that I have just pointed out could not have been committed; for it would have been seen what compass and variety of faculties are required to constitute mathematical genius, and how various are the forms in which that genius manifests itself. One great geometer has shone by the sagacity of his inventions; another by the strength and extent of his combinations; a third by the happy choice of his notations, and the perfection of his algebraic style, etc. We might discover, or at least verify, all the real fundamental intellectual faculties by the scientific class alone. In an inferior degree it would be the same with an analogous study of the most eminent artists. This consideration, in its utmost extent, is connected with the utility of the philosophical study of the sciences, under the historical as well as the dogmatical point of view, for the discovery of the logical laws concerned: the difference being that, in this last case, we have first to determine the elementary faculties, and not the laws of their action: but the grounds must be essentially analogous.

Phrenological analysis has, then, to be reconstituted; first in the anatomical, and then in the physiological order; and finally, the two must be harmonized; and not till then can phrenological physiology be established upon its true scientific basis. Such a procedure is fairly begun, as we have seen, with regard to the two preceding divisions of our science; but it is not yet even conceived of in relation to cerebral physiology, from its greater complexity and more recent positivity.

Pathological and Comparative analysis.

The phrenologists must make a much more extensive use than hitherto of the means furnished by biological philosophy for the advancement of all studies relating to living bodies: that is, of pathological, and yet more of comparative analysis. The luminous maxim of M. Broussais, which lies at the foundation of medical philosophy,—that the phenomena of the pathological state are a simple prolongation of the phenomena of the normal state, beyond the ordinary limits of variation,—has never been duly applied to intellectual and moral phenomena: yet it is impossible to understand anything of the different kinds of madness, if they are not examined on this principle. Here, as in a former division of the science, we see that the study of malady is the way to understand the healthy state. Nothing can aid us so well in the discovery of the fundamental faculties as a judicious study of the state of madness, when each faculty manifests itself in a degree of exaltation which separates it distinctly from others. There has been plentiful study of monomania; but it has been of little use, for want of a due connection and comparison with the normal state. The works that have appeared on the subject have been more literary than scientific; those who have had the best opportunity for observation have been more engaged in governing their patients than in analyzing their cases; and the successors of Pinel have added nothing essential to the ameliorations introduced by him, half a century ago, in regard to the theory and treatment of mental alienation. As for the study of animals, its use has been vitiated by the old notions of the difference between instinct and intelligence. Humanity and animality ought reciprocally to cast light upon each other. If the whole set of faculties constitutes the complement of animal life, it must surely be that all that are fundamental must be common to all the superior animals, in some degree or other: and differences of intensity are enough to account for the existing diversities,—the association of the faculties being taken into the account, on the one hand, and, on the other, the improvement of Man in society being set aside. If there are any faculties which belong to Man exclusively, it can only be such as correspond to the highest intellectual aptitudes: and this much may appear doubtful if we compare, in an unprejudiced way, the actions of the highest mammifers with those of the least-developed savages. It seems to me more rational to suppose that power of observation and even of combination exists in animals, though in an immeasurably inferior degree; the want of exercise, resulting chiefly from their state of isolation, tending to benumb and even starve the organs. Much might be learned from a study of domestic animals, though they are far from being the most intelligent. Much might be learned by comparing their moral nature now with what it was at periods nearer to their first domestication; for it would be strange if the changes that they have undergone in so many physical respects had been unaccompanied by variation in the functions which more easily than any others admit of modification. The extreme imperfection of phrenological science is manifest in the pride with which Man, from the height of his supremacy, judges of animals as a despot judges of his subjects; that is, in the mass, without perceiving any inequality in them worth noticing. It is not the less certain that, surveying the whole animal hierarchy, the principal orders of this hierarchy sometimes differ more from each other, in intellectual and moral respects, than the highest of them vary from the human type. The rational study of the mind and the ways of animals has still to be instituted,—nothing having yet been done but in the way of preparation. It promises an ample harvest of important discovery directly applicable to the advancement of the study of Man, if only the naturalists will disregard the declamation of theologians and metaphysicians about their pretended degradation of human nature, while they are, on the contrary, rectifying the fundamental notion of it by establishing, rigorously and finally, the profound differences which positively separate us from the animals nearest to us in the scale.

Laws of action.

The two laws of action—intermission and association—require much more attention than they have yet received in connection with cerebral physiology. The law of intermittence is eminently applicable to the functions of the brain—the symmetry of the organs being borne in mind. But this great subject requires a new examination, seeing that it is requisite for science to reconcile their evident intermittence with the perfect continuity that seems to be involved in the connection which mutually unites all our intellectual operations, from earliest infancy to extreme decrepitude, and which can not be interrupted by the deepest cerebral perturbations, provided they are transient. This question, for which metaphysical theories allowed no place, certainly offers serious difficulties; but its positive solution must throw great light upon the general course of intellectual acts. As for the association of the faculties, in sympathy or synergy, the physiologists begin to understand its high importance, though its general laws have not yet been scientifically studied. Without this consideration, the number of propensities, sentiments, or aptitudes, would seem to be susceptible of any degree of multiplication. For one instance, investigators of human nature have been wont to distinguish various kinds of courage, under the names of civil, military, etc., though the original disposition to brave any kind of danger must always be uniform, but more or less directed by the understanding. No doubt, the martyr who endures the most horrible tortures with unshaken fortitude rather than deny his convictions, and the man of science who undertakes a perilous experiment after having calculated the chances, might fly in the field of battle if compelled to fight for a cause in which they felt no interest; but not the less is their kind of courage the same as that of the brave soldier. Apart from inequalities of degree, there is no other difference than the superior influence of the intellectual faculties. Without the diverse cerebral synergies, either between the two great orders of faculties, or between the different functions of each order, it would be impossible to analyze the greater proportion of mental actions; and it is in the positive interpretation of each of them by such association that the application of phrenological doctrine will chiefly consist, when such doctrine shall have been scientifically erected. When the elementary analysis shall have been instituted, allowing us to pass on to the study of these compound phenomena, we may think of proceeding to the more delicate inquiry whether, in each cerebral organ, a distinct part is not especially appropriate to the establishment of these synergies and sympathies. Some pathological observations have given rise to this suspicion—the gray substance of the brain appearing more inflamed in those perturbations which affect the phenomena of the will, and the white in those which relate to intellectual operations.

Intermittence and continuity.

Association.

If our existing phrenology isolates the cerebral functions too much, it is yet more open to reproach for separating the brain from the whole of the nervous system. Bichat taught us that the intellectual and affective phenomena, all-important as they are, constitute, in the whole system

Unity of the brain and nervous system.

of the animal economy, only an intermediate agency between the action of the external world upon the animal through sensorial impressions, and the final reaction of the animal by muscular contractions. Now, in the present state of phrenological physiology, no positive conception exists with regard to the relation of the series of cerebral acts to this last necessary reaction. We merely suspect that the spinal marrow is its immediate organ. Even if cerebral physiology carefully comprehended the whole of the nervous system, it would still, at present, separate it too much from the rest of the economy. While rightly discarding the ancient error about the seat of the passions being in the organs of the vegetative life, it has too much neglected the great influence to which the chief intellectual and moral functions are subject from other physiological phenomena, as Cabanis pointed out so emphatically while preparing the way for the philosophical revolution which we owe to Gall.

Imperfect state of Phrenology.

We have now seen how irrational and narrow is the way in which intellectual and moral physiology is conceived of and studied; and that till this is rectified, the science, which really appears not to have advanced a single step since its institution, can not make any true progress. We see how it requires, above even the other branches of physiology, the preparation of scientific habits, and familiarity with the foregoing departments of natural philosophy; and how, from its vicious isolation, it tends to sink to the level of the most superficial and ill-prepared minds, which will make it the groundwork of a gross and mischievous quackery, if the true scientific inquirers do not take it out of their hands. No inconveniences of this kind, however, should blind us to the eminent merits of a conception which will ever be one of the principal grounds of distinction of the philosophy of the nineteenth century, in comparison with the one which preceded it.

Present state of Biology.

Looking back, on the completion of this survey of the positive study of living bodies, we see that, imperfect as it is, and unsatisfactory as are the parts which relate to life, compared with those which relate to organization, still the most imperfect have begun to assume a scientific character, more or less clearly indicated, in proportion to the complexity of the phenomena.

Retrospect of Natural Philosophy.

We have now surveyed the whole system of natural philosophy, from its basis in mathematical, to its termination in biological, philosophy. Notwithstanding the vast interval embraced by these two extremities, we have passed through the whole by an almost insensible gradation, finding nothing hypothetical in the transition, through chemistry, from inorganic to organic philosophy, and verifying as we proceeded the rigorous continuity of the system of the natural sciences. That system, though comprehending all existing knowledge, is, however, still incomplete, leaving a wide area to the retrograde influence of the theologico-metaphysical philosophy, to which it abandons a whole order of ideas, the most immediately applicable of all. There is yet wanting, to complete the body of positive philosophy, and to organize its universal preponderance, the subjection to it of the most complex and special phenomena of all—those of humanity in a state of association. I shall therefore venture to propose the new science of *Social Physics*, which I have found myself compelled to create, as the necessary complement of the system. This new science is rooted in biology, as every science is in the one which precedes it; and it will render the body of doctrine complete and indivisible, enabling the human mind to proceed on positive principles in all directions whatever, to which its activity may be incited. Imperfect as the preceding sciences are, they have enough of the positive character to render this last transformation possible: and when it is effected, the way will be opened for their future advancement through such an organization of scientific labor as must put an end to the intellectual anarchy of our present condition.

BOOK VI.

SOCIAL PHYSICS.

CHAPTER I.

NECESSITY AND OPPORTUNENESS OF THIS NEW SCIENCE.

In the five foregoing parts of this work, our investigation proceeded on an ascertained and undisputed scientific basis; and our business was to exhibit the progress made in each science; to free it from entanglement with the ancient philosophy; and to show what further improvements might be anticipated. Our task is a different, and a much harder one, in the case of the sixth and last science that I am about to treat of. The theories of Social science are still, even in the minds of the best thinkers, completely implicated with the theologico-metaphysical philosophy, and are even supposed to be, by a fatal separation from all other science, condemned to remain so involved for ever. The philosophical procedure which I have undertaken to carry through becomes more difficult and bold, from this point onward, without at all changing its nature or object; and it must so far present a new character as it must henceforth be employed in creating a wholly new order of scientific conceptions, instead of judging, arranging, and improving such as already existed.

It is not to be expected that this new science can be at once raised to a level with even the most imperfect of those which we have been reviewing. All that can be rationally proposed in our day is to recognise the character of positivity in social as in all other science, and to ascertain the chief bases on which it is founded; but this is enough, as I hope to show, to satisfy our most urgent intellectual necessities, and even the most imperative needs of immediate social practice. In its scientific connection with the rest of this work, all that I can hope to do is to exhibit the general considerations of the case, so as to resolve the intellectual anarchy which is the main source of our moral anarchy first, and then of the political, which I shall treat of only through its originating causes. The extreme novelty of such a doctrine and method renders it necessary, before entering upon the

Proposal of the subject.

immediate subject, to set forth the importance of such a procedure, and the futility of the chief attempts which have been indirectly made to investigate social science. However unquestionable may be the need of such science, and the obligation to discover it, the best minds have not yet attained a point of view from which they can estimate its depth and breadth and true position. In its nascent state every science is implicated with its corresponding art; and remains implicated with it, as we have seen, the longer in proportion to the complexity of the phenomena concerned. If biological science, which is more advanced than social, is still too closely connected with the medical art, as we have seen that it is, we cannot be surprised that men are insensible to the value of all social speculations which are not immediately connected with practical affairs. We cannot be surprised at any obstinacy in repelling them, as long as it is supposed that by rejecting them society is preserved from chimerical and mischievous schemes: though experience has abundantly shown that the precaution has never availed, and that it does not now prevent our being daily invaded by the most illusory proposals on social matters. It is in deference, as much as is reasonable, to this apprehension that I propose to state, first, how the institution of a science of Social Physics bears upon the principal needs and grievances of society, in its present deplorable state of anarchy. Such a representation may perhaps convince men worthy of the name of statesmen that there is a real and eminent utility in labors of this kind, worthy of the anxious attention of men who profess to devote themselves to the task of resolving the alarming revolutionary constitution of modern societies.

From the point of view to which we have been raised by our study of the preceding sciences, we are able to survey the social situation of our own time in its fullest extent and broadest light; and what we see is that there is a deep and widely-spread anarchy of the whole intellectual system, which has been in this state of disturbance during the long interregnum, resulting from the decline of the theologico-mataphysical philosophy. At the present time the old philosophy is in a state of imbecility, while the development of the positive philosophy, though always proceeding, has not yet been bold, broad, and general enough to comprehend the mental government of the human race. We must go back through that interregnum to understand truly the present floating and contradictory state of all great social ideas, and to perceive how society is to be delivered from the peril of dissolution, and brought under a new organization, more consistent and more progressive than that which once rested on the theological philosophy. When we have duly observed the powerlessness of conflicting political schools, we shall see the necessity of introducing an entirely new spirit into the organization of society, by which these useless and passionate struggles may be put an end to, and society led out of the revolutionary state in which it has been tossed about for three centuries past.

Conditions of Order and Progress.

The ancients used to suppose Order and Progress to be irreconcilable: but both are indispensable conditions in a state of modern civilization; and their combination is at once the grand difficulty and the main resource of every genuine political system. No real order can be established, and still less can it last, if it is not fully compatible with progress: and no great progress can be accomplished if it does not tend to the consolidation of order. Any conception which is so devoted to one of these needs as to prejudice the other, is sure of rejection, sooner or later, as mistaking the nature of the political problem. Therefore, in positive social science, the chief feature must be the union of these two conditions, which will be two aspects, constant and inseparable, of the same principle. Throughout the whole range of science, thus far, we have seen that the conditions of combination and of progress are originally identical: and I trust we shall see, after looking into social science in the same way, that ideas of Order and Progress are in Social Physics, as rigorously inseparable as the ideas of Organization and Life in Biology; from whence indeed they are, in a scientific view, evidently derived.

The misfortune of our actual state is that the two ideas are set up in radical opposition to each other—the retrograde spirit having directed all efforts in favor of Order, and anarchical doctrine having arrogated to itself the charge of Social Progress; and, in this state of things, the reproaches exchanged between the respective parties are only too well merited by both. In this vicious circle is society now confined; and the only issue from it is by the undisputed preponderance of a doctrine equally progressive and hierarchical. The observations which I have to make on this subject are applicable to all European societies, which have, in fact, all undergone a common disorganization, though in different degrees, and with various modifications, and which cannot be separately reorganized, however they may be for a time restrained; but I shall keep the French nation chiefly in view, not only because the revolutionary state has been most conspicuous in them, but because they are, in all important respects, better prepared, in spite of appearances, than any other, for a true reorganization.

Among the infinite variety of political ideas which appear to be striving in society, there are in fact only two orders, the mingling of which in various proportions occasions the apparent multiplicity: and of these two, the one is really only the negation of the other. If we wish to understand our own condition, we must look at it as the result and last term of the general conflict undertaken, for three centuries past, for the gradual demolition of the old political system. So regarding it, we see that whereas, for above half a century, the irremediable decay of the old system has proved the necessity of founding a new one, we have not been sufficiently aware of the need to have formed an original and direct conception, adequate to the purpose; so that our theoretical ideas have remained inferior to our practical necessities, which, in a healthy state of the social organism, they habitually anticipate, to prepare for their regular and peaceable satisfaction. Though the political movement could not but have changed its nature, from that time forward, becoming organic instead of critical, yet, for want of a basis in science, it has proceeded on the same old ideas that had actuated the past struggle; and we have witnessed the spectacle of defenders and assailants alike endeavoring to convert their old weapons of war into instruments of reorganization, without suspecting the inevitable failure which must ensue to both parties. Such is the state that we find ourselves in now. All ideas of order in the political world are derived from the old doctrine of the theological and military system, regarded especially in its catholic and feudal constitution: a doctrine which from our point of view in this work, represents the theological state of social science: and, in the same way, all ideas of progress are still derived from the purely negative philosophy which, issuing from protestantism, assumed its final form and development in the last century, and which, applied to social affairs, constitutes the metaphysical state of politics. The different classes of society range themselves on the one side or the other, according to their inclination for conservatism or amelioration. With every new uprising of a social difficulty, we see the retrograde school proposing, as the only certain and universal remedy, the restoration of the corresponding part of the old political system; and the critical school referring the evil exclusively to the destruction of the old system not being complete. We do not often see the two doctrines presented without modification. They so exist only in purely speculative minds. But when we see them in monstrous alliance, as we do in all degrees of political opinion, we can not but know that such an alliance can not yield any virtue which its elements do not contain, and that it can only exhibit their mutual neutralization. We must here, it is clear, regard the theological and the metaphysical politics separately, in the first place, that we may afterward understand their present antagonism, and form an estimate of the futile combinations into which men have endeavored to force them.

The theological polity.

Pernicious as the theological polity may be in our day, no true philosopher will ever forget that it afforded the beneficent guardianship under which the formation and earliest development of modern societies took place. But it is equally incontestable that, for three centuries past, its influence among the most advanced nations, has been essentially retrograde, notwithstanding some partial services. We need not go into any discussion of its doctrine, in order to ascertain its powerlessness for future service: for it is plain that a polity that could not hold its ground before the natural progress of intelligence and of society can never again serve as a basis of social order. The historical analysis which I shall have to offer of the causes that have dissolved the catholic and feudal system will show, better than any argument, how radical and irretrievable is the decay. The theological school explains the fact, as far as it can, by fortuitous and, we might almost say, personal causes: and when they will no longer suffice, resorts to its common supposition, of a mysterious caprice of Providence which has allotted to social order a season of probation, of which no account can be given, either as to its date or its duration, or even its character. A contemplation of historical facts however shows that all the great successive modifications of the theological and military system have, from the beginning and increasingly, tended to the complete elimination of a *régime* which, by the fundamental law of social evolution, could never be more than provisional, however indispensable. And if any efforts to restore the system could achieve a temporary success, they would not bring back society to a normal state, but would merely restore the very situation which compelled the revolutionary crisis, by obliging it to set about the work of destruction again, with more violence, because the *régime* has altogether ceased to be compatible with progress in the most essential respects. While avoiding all controversy on so plain a case, I must briefly present a new view which appears to me to point out the simplest and surest criterion of the value of any social doctrine, and which emphatically condemns the theological polity.

Criterion of social doctrine.

Regarded from the logical point of view, the problem of our social reorganization seems to me reducible to this one condition: to construct rationally a political doctrine which, in the whole of its active development, shall be always fully consequent on its own principles. No existing doctrines approach to a fulfilment of this condition: all contain, as indispensable elements, numerous and direct contradictions on the greater number of important points. It may be laid down as a principle that the doctrine which furnishes accordant solutions on the various leading questions of polity, without failing in this one respect in the course of application, must, by this indirect test alone, be recognized as sufficiently adapted to reorganize society; since this intellectual reorganization must mainly consist in re-establishing harmony in the troubled system of our social ideas. When such a regeneration shall have been accomplished in an individual mind (and in that way it must begin), its generalization, sooner or later, is secure; for the number of minds can not increase the difficulty of the intellectual convergence, but only defer the success. We shall hereafter find how great is the superiority of the positive philosophy in this view; because, once extended to social phenomena, it must connect the different orders of human ideas more completely than could be done in any other way.

Failure of the theological polity.

The accomplishment of this great logical condition might be expected from the theological polity above all others, because its doctrine is limited to co-ordinating a system so clearly defined by its long application, and so fully developed in all its essential parts, that it may well be supposed secure from all serious inconsistency. The retrograde school accordingly extols habitually, as its characteristic attribute, the perfect coherence of its ideas, in contrast with the contradictions of the revolutionary school. Yet, though the theological polity is less inconsistent than the metaphysical, it shows a daily increasing tendency to concessions of the most radical importance, directly contrary to all its essential principles. This is evidence enough of the futility of a doctrine which does not even possess the one quality most spontaneously correspondent to its nature. The old political system is seen to be destroyed as soon as its most devoted adherents have lost the true general sentiment of it: and this may now be observed, not only in active practice, but among purely speculative minds of a high order, which are unconsciously modified by the irresistible influences of their age. If examples are desired, we need only bring the retrograde doctrine into comparison with the elements of modern civilization. There can be no doubt that the development of the sciences, of industry, and even of the fine arts, was historically the principal, though latent cause, in the first instance, of the irretrievable decline of the theological and military system. At present, it is the ascendency of the scientific spirit which preserves us from any real restoration of the theological spirit; as, again, the industrial spirit, in its perpetual extension, constitutes our best safeguard against any serious recurrence of the military or feudal spirit. Whatever may be the names given to our political struggles, this is the real character of our social antagonism. Now, amidst this state of things, do we hear of such a thing as any government, or even any school, seriously proposing a systematic repression of science, industry, and art? Do not all powers (with an eccentric exception here and there) claim the honor of encouraging their progress? Here we have the first inconsistency of the retrograde polity, annulling its own project of a restoration of the past: and though the inconsistency is less apparent than some others, it must be regarded as the most decisive of all, because it is more universal and more instinctive than any other. Napoleon Bonaparte himself, the hero of retrogression in our time, set himself up, in all sincerity, as the protector of industry, art, and science. Purely speculative minds, though more easily separating themselves from any prevalent tendency, have escaped no better from the influence of their times. How many have been the attempts, for instance, for two centuries past, on the part of some of the most eminent minds, to subordinate reason to faith, according to the theological formula; reason itself being made the supreme judge of such a submission, and thus evidencing the contradictory character of the proposition! The most eminent thinker of the Catholic school, the illustrious De Maistre, bore involuntary testimony to the necessity of his time when he endeavored, in his principal work, to re-establish the papal supremacy on historical and political reasonings, instead of ordaining it by divine right, which is the only ground appropriate to such a doctrine, and the only ground he would have proposed in any age but one in which the general state of intelligence precluded such a plea. Instances like these may spare us further illustration.

As for more direct inconsistencies, more striking, though less profound, and comprehended within the present times, we see in every sect of the retrograde school a direct opposition to some fundamental part of their common doctrine. Perhaps the only point on which there is now any unanimity in that school is in the consent to break up the very basis of the catholic and feudal system, by surrendering the division between the spiritual and temporal power; or, what comes to the same thing, acquiescing in the subordination of the spiritual to the temporal authority. In this respect, the kings are showing themselves as revolutionary as their peoples; and the priests have ratified their own degradation, in catholic countries no less than protestant. If their desire is to restore the old system, their first step must be to unite the innumerable sects which have sprung out of the decline of Christianity; but every attempt of the sort has failed through the blind and obstinate determination of the governments to retain the supreme direction of the theological power, the centralization of which they thus render impossible. Napoleon only showed an exaggerated copy, in his violent inconsistencies, of what many princes had done before him: and after his fall, when the sovereigns of Europe united to set up a power in opposition to revolutionary tendencies, they usurped the attributes of the old spiritual authority, and exhibited the spectacle of a high council composed of heretic chiefs, and governed by a schismatic prince. After this it was manifestly impossible to introduce the papal power into the alliance, in any way whatever. Such instances of the postponement of religious principles to temporal convenience are not new; but they show how the main idea of the old political system has ceased to preponderate in the minds of the very persons who undertook to restore it. The divisions in the retrograde school have been of late apparent under all circumstances, whether of success or defeat. Any temporary success ought to rally all dissentients, in a school which boasts of the unity of its doctrine: yet, through a long course of years we have witnessed successive, and more and more serious schisms among the subdivisions of the triumphant party. The advocates of catholicism and those of feudality have quarrelled: and the latter have split into partisans of aristocracy and defenders of royalty. Under the completest restored supremacy, the schisms would only break out again, with more violence, through the incompatibility of the existing social state with the old political system. The vague assent to its general principles which it yielded in a speculative sense must give way in their application; and every practical development must engender further divisions: and this is the scientific description of any theory which is incompatible with the facts.

When the retrograde party is reduced to the rank of an opposition, it has recourse to the principles of the revolutionary doctrine. This has been the case repeatedly during the last three centuries, when that party has been put upon the defensive. Thus we see the Catholics in England, and yet more in Ireland, asserting the claim of liberty of conscience, while still clamoring for the repression of Protestantism in France, Austria, and elsewhere. Again, when the sovereigns of Europe invoked the aid of the peoples to put down Napoleon, they surrendered their retrograde doctrine, and testified to the power of the critical, as that which was really influencing civilized society, even though they were proposing, all the while, to effect the restoration of the ancient polity. We have seen something even more wonderful since that struggle. We have seen the retrograde party taking possession of the whole body of critical doctrine, endeavoring to systematize it for its own uses, and sanctioning all its anarchical consequences; trying to set up the catholic and feudal *régime* by the very means which have destroyed it; and believing that a mere change in the person of the sovereign would intercept the consequences of a political movement which they had done nothing to modify.* This is simply a new way of signing a political abdication, however the ability of those who do it may be extolled.—We need not look further for illustrations of the pregnant fact that a polity which is the type of unity and permanence has been full of schisms, and now contains elements directly incompatible with its fundamental principles; and that, as when we find De Maistre reproaching Bossuet with mistaking the nature of catholicism, and then himself falling into inconsistencies, the party of Order is proposing to re-establish that which is not comprehended by its most illustrious defenders.

The Metaphysical polity. Turning now to the Metaphysical polity, we must first observe and carefully remember that its doctrine, though exclusively critical, and therefore revolutionary, has still always had the virtue of being progressive, having, in fact, superintended the chief political progress accomplished during the last three centuries, which must be, in the first instance, essentially negative. What this doctrine had to do was to break up a system which, having directed the early growth of the human mind and society, tended to protract that infantile period: and thus, the political triumph of the metaphysical school was a necessary preparation for the advent of the positive school, for which the task is exclusively reserved of terminating the revolutionary period by the formation of a system uniting Order with progress. Though the metaphysical system, considered by itself, presents a character of direct anarchy, an historical view of it, such as we shall take hereafter, shows that, considered in its origin, and in its antagonism to the old system, it constitutes a necessary provisional state, and must be dangerously active till the new political organization which is to succeed it is ready to put an end to its agitations.

The passage from one social system to another can never be continuous and direct. There is always a transitional state of anarchy which lasts for some generations at least; and lasts the longer the more complete is the renovation to be wrought. The best political progress that can be made during such a period is in gradually demolishing the former system, the foundations of which had been sapped before. While this inevitable process is going on, the elements of the new system are taking form as political institutions, and the reorganization is stimulated by the experience of the evils of anarchy. There is another reason why the constitution of the new system can not take place before the destruction of the old; that without that destruction no adequate conception could be formed of what must be done. Short as is our life, and feeble as is our reason, we can not emancipate ourselves from the influence of our environment. Even the wildest dreamers reflect in their dreams the contemporary social state: and much more impossible is it to form a conception of a true political system, radically different from that amidst which we live. The highest order of minds can not discern the characteristics of the coming period till they are close upon it; and before that, the incrustations of the old system will have been pretty much broken away, and the popular mind will have been used to the spectacle of its demolition. The strongest head of all antiquity is an example of this. Aristotle could not conceive of a state of society that was not founded on slavery, the irrevocable abolition of which took place some centuries after him.—These considerations are illustrative of our own times, for which all former transition periods were merely a preparation. Never before was the destined renovation so extensive and so thorough; and never before, therefore, was the critical preparatory period so protracted and so perilous. For the first time in the history of the world, the revolutionary action is attached to a complete doctrine of methodical negation of all regular government. Such being the origin of the existing critical doctrine, we can explain the services which that doctrine has hitherto rendered, and the obstacles which it now opposes to the reorganization of modern society. We shall see hereafter how each of its principal dogmas has sprung out of some corresponding decay in the old social order; a decay which then proceeded all the faster for the opposition having become a dogma. The misfortune of the case lies in the doctrine which was thus necessarily relative to the old system coming by degrees to be supposed absolute; but we may leave it to those who desire it to blame the political conduct of our fathers, without whose energetic perseverance we should not have found ourselves at our present stage of progress, or have been able to conceive of the better polity that is approaching. The absolute or metaphysical spirit was necessary to direct the formation of the critical and anti-theological doctrine, which needed all possible energy to overthrow the great ancient system; and this energy could no otherwise be imparted to the dogmas of the critical philosophy. The necessity and the fact of the case are obvious enough: but not the less must we deplore the consequence,—that the energy imparted to the anarchical principle has gone on to impede the institution of the very political order for which it came to prepare the way. When, in the natural course of events, any doctrine has become hostile to the purposes it was destined to serve, it is evidently done with; and its end, or the close of its activity, is near. We have seen that the retrograde or theological polity has become as disturbing as the metaphysical or revolutionary: if we find also that the latter, whose office was to aid progress, has become obstructive, it is clear that both doctrines are worn out, and must soon be replaced by a new philosophy.—This condition of the metaphysical polity is a matter so serious that we must dwell upon it a little, to see how so provisional an influence can have produced the appearance of a new and stable system.

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* This was written during the reign of Louis Philippe, and the administration of M. Guizot.

Becomes obstructive.

The spirit of revolutionary polity is to erect into a permanency the temporary action which it prompts. For instance, being in antagonism with ancient order, its tendency is to represent all government as being the enemy of society, and the duty of society to be to keep up a perpetual suspicion and vigilance, restricting the activity of government more and more, in order to guard against its encroachments, so as to reduce it at length to mere functions of police, in no way participating in the supreme direction of collective action and social development. This was the inevitable action by which the social evolution was brought about: and it is our misfortune that it now remains as an obstacle to the reorganization that we need. As the process could not but occupy several centuries, the power that wrought it must needs be invested with something definitive and absolute in the popular view, which can not look far beyond the present: and it was well that it was so; for the old system could not have been deprived of its directing powers, if they had not been stripped off from the governments, and assumed by the polity which had arisen to supersede them.

Dogma of liberty of conscience.

Regarding the doctrine in a more special view, it is clear that its most important principle is the right of free inquiry, or the dogma of unbounded liberty of conscience; involving the immediate consequences of the liberty of the press, or of any other mode of expression, and of communication of opinions. This is the rallying-point of the revolutionary doctrine, to which all orders of minds have come up,—the proud and the humble, the wise and the weak,—those whose other opinions were compatible with this dogma, and those who unconsciously held views of an opposite order. The impulse of this emancipation was irresistible; and the revolutionary contagion was, in this one respect, universal. It is a chief characteristic of the mind of society in this century. The most zealous partisans of the theological polity are as apt as their adversaries to judge by their personal knowledge; and those who, in their writings, set up as defenders of spiritual government, recognise, like the revolutionists whom they attack, no other supreme authority than that of their own reason. Now if we look at what is the real meaning of this dogma of the universal and absolute right of inquiry, we shall find that it is the mere abstract expression (such as is common in metaphysics) of the temporary state of unbounded liberty in which the human mind was left by the decay of the theological philosophy, and which must last till the social advent of the positive philosophy. Such an embodiment of the fact of the absence of intellectual regulation powerfully concurred in expediting the dissolution of the old system. The formula could not but appear absolute at the time, because no one could foresee the scope of the transitional state which it marked; a state which is even now mistaken by many enlightened minds for a definitive one. Negative as we now see this dogma to be, signifying release from old authority while waiting for the necessity of positive science (a necessity which already puts liberty of conscience out of the question in astronomy and physics, etc.), the absolute character supposed to reside in it gave it energy to fulfil its revolutionary destination; enabled philosophers to explore the principles of a new organization; and, by admitting the right of all to a similar research, encouraged the discussion which must precede and effect the triumph of those principles. Whenever those principles shall have become established, the right of free inquiry will abide within its natural and permanent limits: that is, men will discuss, under appropriate intellectual conditions, the real connection of various consequences with fundamental rules uniformly respected. Till then, the opinions which will hereafter bring understandings into submission to an exact continuous discipline by embodying the principles of the new social order can appear only as simple individual thoughts, produced in virtue of the right of free inquiry; since their final supremacy can result in no other way than from the voluntary assent of numbers, after the freest discussion. I shall enter further into this subject hereafter: and what I have said will, I hope, prevent any one being shocked by my general appreciation of the revolutionary dogma of free inquiry, as it is plain that without it this book would never have been written.

Indispensable and salutary as it has been, this dogma can never be an organic principle: and, moreover, it constitutes an obstacle to reorganization, now that its activity is no longer absorbed by the demolition of the old political order. In any case, private or public, the state of inquiry can evidently be only provisional, indicating the condition of mind which precedes and prepares for a final decision, toward which our reason is always tending, even when it is renouncing old principles, in order to form new ones. It is taking the exception for the rule when we set up, as a natural and permanent state, the precarious situation which belongs to the period of transition; and we ignore the deepest necessities of human reason when we would protract that skepticism which is produced by the passage from one mode of belief to another, and which is, in our need of fixed points of conviction, a kind of morbid perturbation which can not be prolonged beyond the corresponding crisis without serious danger. To be always examining and never deciding would be regarded as something like madness in private conduct: and no dogmatic consecration of such conduct in all individuals could constitute any perfection of social order, with regard to ideas which it is much more essential, and much more difficult to establish beyond the reach of dispute. There are very few persons who consider themselves fit to sit in judgment on the astronomical, physical, and chemical ideas which are destined to enter into social circulation; and everybody is willing that those ideas should direct corresponding operations; and here we see the beginnings of intellectual government. Can it be supposed that the most important and the most delicate conceptions, and those which by their complexity are accessible to only a small number of highly-prepared understandings, are to be abandoned to the arbitrary and variable decisions of the least competent minds? If such an anomaly could be imagined permanent, a dissolution of the social state must ensue, through the ever-growing divergence of individual understandings, delivered over to their disorderly natural impulses in the most vague and easily-perverted of all orders of ideas. The speculative inertia common to most minds, and perhaps, to a certain extent, the wise reserve of popular good sense, tend, no doubt, to restrict such political aberrations: but these are influences too feeble to root out the pretension of every man to set himself up as a sovereign arbiter of social theories;—a pretension which every intelligent man blames in others, with a reservation, more or less explicit, of his own personal competency. Now the intellectual reorganizationcan not proceed amidst such a state af things, because the convergence of minds requires the renunciation by the greater number of their right of individual inquiry on subjects above their qualifications, and requiring, more than any others, a real and permanent agreement. Then again, the unbridled ambition of ill-prepared intellects rushes in among the most complex and obscure questions; and these disturbances, though they must finally neutralize each other, make terrible devastation in the interval; and each one that is destroyed makes way for another; so that the issue of these controversies is a perpetual aggravation of the intellectual anarchy.

No association whatever, even of the smallest number of individuals, and for the most temporary objects, can subsist without a certain degree of reciprocal confidence, intellectual and moral, among its members, each one of whom has incessantly to act upon views which he must admit on the faith of some one else. If it is so in this limited case, there is something monstrous in proposing the opposite procedure in the case of the whole human race, each one of whom is at an extreme distance from the collective point of view, and is the last person of the whole number fit to judge of the rules by which his personal action should be directed. Be the intellectual development of each and all what it may, social order must ever be incompatible with a perpetual discussion of the foundations of society. Systematic toleration can exist only with regard to opinions which are considered indifferent or doubtful, as we see in that aspect of the revolutionary spirit which takes its stand on Protestantism, where the innumerable Christian sects are too weak to pretend to spiritual dominion, but where there is as fierce an intolerance about any common point of doctrine or discipline as in the Romish Church itself. And when the critical doctrine was, at the beginning of the French Revolution, supposed to be organic, we know how the directors of the movement strove to obtain a general assent, voluntary or forced, to the dogmas of the revolutionary philosophy, which they regarded as the bases of social order, and therefore above controversy. We shall see hereafter what are the due limits of the rights of free inquiry, in a general way, and in regard to our own social period. It is enough to observe here that political good sense has adopted, to express the first requisite of all organization, that fine axiom of the Catholic Church: *in necessary things, unity: in doubtful things, liberty: in all things, charity:* a maxim which admirably proposes the problem, without, however, suggesting the principles by which it must be solved, and that unity attained which would be a mere illusion if it did not result, in the first instance, from free discussion.

Dogma of Equality.

The dogma which ranks next in importance to that of free inquiry is that of Equality; and in the same way, it is taken to be absolute when it is only relative, and permanent while it expresses merely the position of minds employed in breaking up the old system. It is an immediate consequence of liberty of conscience, which brings after it the most fundamental equality of all,—that of intelligence. The supposition of its being absolute was not less necessary in this case than the former: for, if all social classification had not been systematically disallowed, the old corporations would have preserved their sway, from the impossibility of their conceiving of any other classification. To this day we have no sufficiently distinct notion ourselves of such an arrangement as would be truly appropriate to a new state of civilization.

When the dogma of equality had achieved the overthrow of the old politics, it could not but become an obstacle to any reorganization, because its activity must then be directed against the bases of any new classification whatever; for, of course, any classification must be incompatible with the equality that was claimed for all. Since the abolition of slavery, there has been no denial, from any quarter, of the right of every man (innocent of strong anti-social conduct) to expect from all others the fulfilment of the conditions necessary to the natural development of his personal activity, suitably directed: but, beyond that undisputed right, men can not be made, because they are not, equal, nor even equivalent; and they can not therefore possess, in a state of association, any identical rights beyond the great original one. The simple physical inequalities which fix the attention of superficial observers are much less marked than intellectual and moral differences; and the progress of civilization tends to increase these more important differences; as much as to lessen the inferior kind: and, applied to any assemblage of persons thus developed, the dogma of equality becomes anarchical, and directly hostile to its original destination.

Dogma of the Sovereignty of the People.

The second result of the dogma of liberty of conscience is the Sovereignty of the people: and, like the former, it wrought at first the double service of destroying the old *régime* and preparing for a new one. Till the final system could be constituted, the only safeguard against the renewed supremacy of the old one was in the setting up of provisional institutions, which the peoples claimed the absolute right to change at will. It was only by means of the doctrine of popular sovereignty that that succession of political endeavors could take place which must precede the installation of a true system of government, whenever the intellectual renovation of society shall be sufficiently advanced to settle the conditions and natural extent of the different sovereignties. Meanwhile, in discharging its function, this dogma proves its revolutionary character before our eyes, by opposing all reorganization, condemning, as it does, all the superior to an arbitrary dependence on the multitude of the inferior, by a kind of transference to the peoples of the divine right which had become the opprobium of kings.

Dogma of National Independence.

The revolutionary spirit of the critical doctrine manifests itself no less clearly when we look at international relations. The necessity of order being in this case more equivocal and obscure, the absence of all regulating power has been more ingenuously declared than in other cases. When the ancient spiritual power was politically annulled, the dissolution of European order followed spontaneously from the principle of liberty of conscience; and the most natural papal function was at an end. Till the new social organization shall show us the law by which the nations shall become once more connected, the metaphysical notions of national isolation, and therefore of mutual non-intervention, must prevail; and they will be regarded as absolute till it appears how they defeat their own end. As all attempts at European coordination must otherwise be directed by the ancient system, we owe to the doctrine of national independence our rescue from the monstrous arrangement of the most civilized nations being politically subordinated to the least advanced, because the latter were least changed from their ancient state, and would be sure therefore to be placed at the head of such an association. But, if such a doctrine were more than provisional, the nations would sink below their state in the Middle Ages; and at the very time when they are marked out, by an ever-growing resemblance, for an association more extensive, and, at the same time more regular, than that which was proposed by the old catholic and feudal system. It is clear that when the dogma of national isolation has fulfilled its function of separating the nations, in order to a preparation for a new union, its further action must be as purely anarchical as that of its predecessors.

A brief notice of the logical inconsistency of the revolutionary doctrine will conclude our preliminary review of it.

Inconsistency of the Metaphysical doctrine.

This inconsistency is more radical and more manifest than in the case of the retrograde or theological doctrine; but it does not imply so utter a condemnation; not only on account of its recent formation, but because such a vice does not prevent its fulfilling its critical office. Notwithstanding profound differences, the adversaries of the old polity found no difficulty in uniting for successive partial demolitions about which they were agreed, postponing till their period of success their contests about the ulterior developments of their doctrine; a course which would be impossible in the case of any organic operation, in which each part must be considered in its relation to the whole. Thus far only, however, can the inconsistency be tolerated. When once the whole of any doctrine becomes hostile to its original purposes, it is condemned: and this is true of the metaphysical doctrine, which at once opposes the progress it professed to aid, and sustains the foundations of the political system it proposed to destroy.

Notion of a state of Nature.

Its culminating point was at the most marked period of the first French Revolution, when it was, by an unavoidable illusion, taken to be the principle of social reorganization. It was then seen in its best aspect of consistency and power; and then it was that, the ancient system being disposed of, its vices became apparent. It showed itself hostile to all social reorganization, and became actually retrograde in its character by setting itself up in violent opposition to the movement of modern civilization. For one illustration, look at the strange metaphysical notion of a supposed state of nature, which was to be the primitive and invariable type of every social state. This doctrine is not to be attributed to Rousseau alone. It is that of all philosophers, in all times and countries, who have unconsciously concurred in developing the revolutionary metaphysical doctrine which Rousseau, by his urgent dialectics, only pushed to its real conclusions. His doctrine, which represents a state of civilization as an ever-growing degeneracy from the primitive ideal type, is common to all modern metaphysicians; and we shall see hereafter that it is only the metaphysical form of the theological dogma of the degradation of the human race by original sin. According to such a principle, all political reformation must be regarded as destined to re-establish that primitive state: and what is that but organizing a universal retrogradation, though with progressive intentions? The applications of this doctrine have been in conformity to its philosophical constitution. When it was necessary to replace the feudal and catholic *régime*, men did not fix their contemplation on the social future, but summoned up their imperfect remembrances of a very distant past, trying to substitute for a decrepit system a more ancient and decrepit system still, but, for that very reason, nearer to the primitive type. Instead of a worn-out catholicism, they proposed a sort of metaphysical polytheism, at the same time that, in polity, they desired to replace the Middle Age system by the radically inferior *régime* of the Greeks and Romans. The very elements of moden civilization, the only possible germs of a new social state, were endangered by barbaric condemnation of the industrial and artistic advancement of modern society, in the name of primitive virtue and simplicity. Even the scientific spirit, which is the only principle of intellectual organization, was stigmatized as tending to institute an aristocracy of knowledge which was as incompatible as any other aristocracy with the original equality that was to be set up again. Lavoisier was the martyr of this state of opinion; and it is his case that will illustrate the period to our remotest posterity. It is useless for the metaphysical school to represent such results as portentous or eccentric incidents. Their legitimate descent from the revolutionary polity is evident and certain; and we should witness a repetition of them if it were possible (which it is not) for this polity to become prevalent again. The tendency to social retrogradation, under the idea of returning to the primitive state, so thoroughly belongs to the metaphysical polity, that the new sects who, in their brief day, have most haughtily censured the revolutionary imitation of Greek and Roman types, have unconsciously reproduced the same error in a far more marked way by striving to re-establish the confusion between the temporal and spiritual power, and extolling, as the highest social perfection, a return to the Egyptian or Hebrew theocracy, founded on fetichism, disguised under the name of pantheism.

Adhesion to the worn-out.

As the metaphysical doctrine was the issue of the theological, and destined to modify it, it was a matter of course that it should vindicate the general foundations of the old system, even after having destroyed its chief conditions of existence. Every reformer, for three centuries past, while urging the development of the critical spirit further than his predecessors, assumed to set immutable bounds to it; deriving his limitations from the old system. All the absolute rights proclaimed as the basis of the new doctrine were guarantied by a sort of religious consecration, in the last resort; and this was indispensable, if their efficacy was not to be impaired by continual discussion. It was always with an invocation of the principles of the old polity on their lips that the reformers proceeded to demolish the spiritual and temporal institutions in which they were embodied; and the whole *régime* fell through the conflict of its chief elements. Hence there arose, in the intellectual region, a Christianity more and more attenuated or simplified, and reduced at last to that vague and impotent theism which, by a monstrous conjunction of terms, metaphysicians have entitled *Natural Religion*, as if all religion were not necessarily supernatural. The pretension to direct a social reorganization by this strange conception is merely a recurrence to the old principle that social order must rest on a theological basis. This is now the most fatal inconsistency of the revolutionary school; and while armed with such a concession, the advocates of catholicism will always have an incontestable logical superiority over the irrational defamers of the old faith, who proclaim the need of a religious organization, and yet disallow all the necessary conditions. It is clear that society would be condemned to a perpetuity of the intellectual anarchy which characterizes it at present if it were to be for ever made up of minds which admit the want of a theological *régime* on the one hand, while, on the other, they reject its principal conditions of existence; and those who thus acknowledge themselves incapable have no right to discredit the only rational way to reorganization which remains open, and by which every other order of human conceptions has been happily retrieved and established. The social application of the positive philosophy remains as the resource, and the only resource, after the failure of both the preceding systems.

Recurrence to war.

In its temporal application the inconsistency of the metaphysical doctrine is as conspicuous as in the spiritual. It strives to preserve, if not the feudal, at least the military spirit, in which the feudal had its origin. The French nation did, it is true, in their revolutionary enthusiasm, proscribe war from that time forward: but when the armed coalition of the retrograde forces of Europe brought out an immense amount of energy for self-defence, for the sake of the progressive movement, the sentiment, which was grounded on no principle, soon disappeared, and France was distinguished by the most conspicuous military activity, invested with its most oppressive characteristics. The military spirit is in fact so congenial with the critical doctrine that any pretext will serve for its indulgence: as for instance, when it is proposed to regulate by war the action of the more advanced nations upon the less advanced. The true logical consequence of this would be a universal uproar; but, happily, the nature of modern civilization saves us from the danger. The tendency of the critical *régime* in this respect is shown by the perpetual endeavors of the various sections of the revolutionary school to reinstate the memory of the man who, of all others, strove for political retrogradation, by wasting enormous amount of power in the restoration of the military and theological system.

Principle of political centralization.

Before quitting the subject of the inconsistencies of this school, I must, in justice, point out one more contradiction which, as being of a progressive character, is honorable to those most advanced minds which entertain it, and which alone understand its necessity, opposed as it is to the dogmas of independence and isolation which constitute the spirit of the critical school. I refer to the principle of political centralization. The two parties seem here to have changed sides. The retrograde doctrine, notwithstanding its proud pretensions to order and unity, preaches the distribution of political centres, in the secret hope of preserving the old system yet a while longer among the most backward of the populations, by keeping them aloof from the general centres of civilization; while the revolutionary policy, on the other hand, proud of having withstood, in France, the coalition of the old powers, discards its own maxims to recommend the subordination of the secondary to the principal centres by which such a noble stand has already been made, and which must become a most valuable auxiliary of reorganization. Thus alone can the reorganization be, in the first place, restricted to a choice population. In brief, the revolutionary school alone has understood that the increasing anarchy of the time, intellectual and moral, requires, to prevent a complete dislocation of society, a growing concentration of political action, properly so called.

Thus, after three centuries, employed in the necessary demolition of the ancient *régime*, the critical doctrine shows itself as incapable of other application, and as inconsistent as we have now seen it to be. It is no more fit to secure Progress, than the old doctrine to maintain Order. But, feeble as they are apart, they actually sustain each other by their very antagonism. It is universally understood that neither can ever again achieve a permanent triumph: but, so strong is the apprehension of even the temporory preponderance of either, that the general mind, for want of a more rational point of support, employs each doctrine in turn to restrain the encroachments of the other. This miserable oscillation of our social life must proceed till a real doctrine as truly organic as progressive, shall reconcile for us the two aspects of the great political problem. Then, at last, the two opposite doctrines will disappear for ever in the new conception that will be seen to be completely adapted to fulfil the destination of both. Often has each party, blinded by some temporary success, believed that it had annihilated the other; and never has the event failed to mock the ignorant exultation. The critical doctrine seemed to have humbled for ever the catholic-feudal school; but that school arose again. Napoleon thought he had accomplished a retrograde reaction; but the very energy of his efforts caused a reaction in favor of revolutionary principles. And thus society continues to vibrate between conflicting influences; and those influences continue to exist only by their mutual neutralization. For that purpose only, indeed, are they now ever applied. Neither could be spared before the advent of the state which is to succeed them. Without the one, we should lose the sentiment of Order, and without the other, that of Progress; and the keeping alive this sentiment, on either hand, is the only practical efficacy which now remains to them. Feeble as the conception must be, in the absence of any principle which unites the two requisites, it is preserved by the presence of the two decaying systems; and they keep before the minds of both philosophers and the public the true conditions of social reorganization, which otherwise our feeble nature might misconceive or lose sight of. Having the two types before us, we see the solution of the great problem to be, to form a doctrine which shall be more organic than the theological, and more progressive than the metaphysical.

The old political system can be no pattern for a *régime* suitable to a widely different civilization; but we are not under the less obligation to study it, in order to learn what are the essential attributes of all social organization, which must reappear in an improved state in the future. The general conception of the theological and military system even seems to me to have passed too much out of sight. And, as to the Critical system, there can be no question of its affording, by its progressive character, and its exposure of the preceding *régime*, a most valuable stimulus to society to seek for something better than mere modifications of systems that have failed. The common complaint that it renders all government impossible, is a mere avowal of impotence on the part of those who utter it. Whatever are its imperfections, it fulfilled for a time one of the two requisites: its abolition would in no way assist the re-establishment of Order; and no declamations against the revolutionary philosophy will affect the instinctive attachment of society to principles which have directed its political progress for three centuries past, and which are believed to represent the indispensable conditions of its future development. Each of its dogmas affords an indication of how the improvement is to be effected. Each expresses the political aspect of certain high moral obligations which the retrograde school, with all its pretensions, was compelled to ignore, because its system had lost all power to fulfil them. In this way, the dogma of Free Inquiry decides that the spiritual reorganization must result from purely intellectual action, providing for a final voluntary and ananimous assent, without the disturbing intervention of any heterogeneous power. Again, the dogmas of Equality and the Sovereignty of the people devolve on the new powers and classes of society the duty of a public-spirited social conduct, instead of working the many for the interests of the few. The old system practised these moralities in its best days; but they are now maintained only by the revolutionary doctrine, which it would be fatal to part with till we have some substitute in these particular respects; for the effect would be that we should be delivered over to the dark despotism of the old system;—to the restorers of religions, for instance, who, if proselytism failed, would have recourse to tyranny to compel unity, if once the principle of free inquiry were lost from among us.

It is useless to declaim against the critical philosophy, and to deplore, in the name of social order, the dissolving energy of the spirit of analysis and inquiry. It is only by their use that we can obtain materials for reorganization; materials which shall have been thoroughly tested by free discussion, carried on till general conviction is secured. The philosophy which will arise out of this satisfaction of the public reason will then assign the rational limits which must obviate the abuse of the analytical spirit, by establishing that distinction in social matters, between the field of reasoning and that of pure observation, which we have found already marked out in regard to every other kind of science.

Though consigned, by the course of events, to a negative doctrine for awhile, society has never renounced the laws of human reason: and when the proper time arrives, society will use the rights of this reason to organize itself anew, on principles which will then have been ascertained and estimated. The existing state of no-government seems necessary at present, in order to that ascertainment of principles; but it does not at all follow, as some eccentric individuals seem to think, that the right of inquiry imposes the duty of never deciding. The prolonged indecision proves merely that the principles which are to close the deliberation are not yet sufficiently established. In the same way, because society claims the right of choosing and varying its institutions and governing powers, it by no means follows that the right is for ever to be used in choosing and varying, when its indefinite use shall have become injurious. When the right conditions shall have been ascertained, society will submit its choice to the rules which will secure its efficacy; and in the interval, nothing can be more favorable to future order than that the political course should be kept open, to admit of the free rise of the new social system. As it happens, the people have, thus far, erred on the side of too hasty a desire for reorganization, and a too generous confidence in every promise of social order, instead of having shown the systematic distrust attributed to the revolutionary doctrine by those whose wornout claims will not bear discussion. There is more promise of political reorganization in the revolutionary doctrine than in the retrograde, though it is the supreme claim of the latter to be the safeguard of social Order.

The Stationary doctrine. Such is the vicious circle in which we are at present confined. We have seen what is the antagonism of two doctrines that are powerless apart, and have no operation but in neutralizing each other. They have lost their activity as preponderating influences, and are seen now in the form of political debate, which they daily direct by the one furnishing all the essential ideas of government, and the other the principles of opposition. At shorter and shorter intervals, a partial and transient superiority is allowed to the one or the other, when its antagonist threatens danger. Out of these oscillations a third opinion has arisen, which is constructed out of their ruins, and takes its station between them. I suppose we must give the name of Doctrine to this intermediate opinion, bastard and inconsistent as is its character; for it is presented by very earnest doctors, who urge it upon us as a type of the final political philosophy. We must call it the Stationary Doctrine; and we see it, in virtue of that quality, occupying the scene of politics, among the most advanced people, for above a quarter of a century. Essentially provisional as it is, the Stationary school naturally serves as a guide to society in preserving the material order, without which a true doctrine could not have its free growth. It may be necessary for our weakness that the leaders of this school should suppose that they have a doctrine which is destined to triumph; but whatever benefits arise from their action are much impaired by the mistake of supposing our miserable transition state a permanent type of the social condition. The stationary polity not only contains inconsistencies, but it is itself inconsistency erected into a principle. It acknowledges the essential principles of the other systems, but prevents their action. Disdainful of Utopias, it proposes the wildest of them all;—that of fixing society for ever in a contradictory position between retrogradation and regeneration. The theory serves to keep in check the other two philosophies; and this may be a good: but, on the other hand, it helps to keep them alive; and it is, in so far, an obstacle to reorganization. When I present my historical review of society, I shall explain the special assemblage of social conditions which gave England her parliamentary monarchy, so lauded by the school of mixed doctrine, but, in fact, an exceptional institution, whose inevitable end can not be very far off. When we enter upon that analysis, we shall see how great is the error of philosophers and statesmen when they have taken up a singular and transient case as the solution of the revolutionary crisis of modern societies, and have endeavored to transplant on the European continent a purely local system, which would be deprived in the process of its very roots: for it is an organized Protestantism which is its main spiritual basis in England. The expectation attached to this single specious aspect of the stationary doctrine will make a future examination of it important; and we shall then see how hopeless is the constitutional metaphysics of the balance of powers, judged by that instance which serves as the common ground of such social fictions. After all the vast efforts made to nationalize elsewhere the stationary compromise, it has never succeeded anywhere but in its native land; and this proves its powerlessness in regard to the great social problem. The only possible result is that the mischief should pass from the acute to the chronic state, becoming incurable by the recognition as a principle of the transient antagonism which is its chief symptom. Its principal merit is that it admits the double aspect of the social problem, and the necessity of reconciling Order and Progress: but it introduces no new idea; and its recognition amounts therefore to nothing more than an equal sacrifice, when necessary of the one and the other. The order that it protects is a merely material order; and it therefore fails in that function precisely in crises when it is most wanted. On the other hand, this function continues to be attributed to royalty, which is the only power of the old polity that is still active: now, the balance which is instituted by the stationary doctrine surrounds the royal power with bonds that are always tightening, while declaring that royal power to be the chief basis of the government. It is only a question of time when the function of sovereignty, thus embarrassed, shall cease, and the pretended balance be destroyed. This parliamentary polity serves the cause of progress no better than that of order: for, as it proposes no new principle, the restraints which it puts upon the revolutionary spirit are all derived from the ancient system, and therefore tend to become more and more retrograde and oppressive. An example of this is, the restrictions on the right of election; restrictions always derived from irrational material conditions, which, being arbitrary in their character, oppress and irritate, without answering their proposed purpose, and leave the multitude of the excluded much more offended than the small number of the privileged are gratified.

There is no need to say more in this place of the mixed or Stationary doctrine, which is, in fact, only a last phase of the metaphysical polity. The reader can not but see that a theory so precarious and subaltern, so far from being able to reorganize modern society, can only regulate, by protracting, the political conflict, and discharge the negative office of preventing kings from retrograding and peoples from destroying. Whatever the value of this service may be, we can not expect regeneration to be accomplished by means of impediments.

Dangers of the critical period.

We have now seen the worth of these three systems. To complete our conviction of the need of a better, we must briefly notice the chief social dangers which result from the deplorable protraction of such an intellectual condition, and which must, from their nature, be aggravated from day to day. The dangers are imputable to all the three systems; though the revolutionary and stationary systems assume that the blame of our disorders rests with the retrograde school: but they are certainly no less guilty; for, powerless to discover the remedy, they protract the mischief and embarrass the treatment. And again, the discordance between the movement of governments and of their peoples is to be attributed quite as much to the hostile spirit of the directing power as to the anarchical tendency of popular opinions. The social perturbations, the aspects of which we are about to examine, proceed no less from the kings than from their peoples, with this aggravated disgrace—that it seems as if the solution ought to emanate from the kings.

Intellectual anarchy.

The first, the most fatal, and the most universal consequence of this situation is the alarming and ever-widening extent of the intellectual anarchy which all acknowledge, however they may differ about its cause and termination. This evil is charged almost exclusively on the revolutionary philosophy; and that school too readily admits the charge. But, as we have seen, that doctrine does not prohibit decision, when the requisite grounds are ascertained: and it is the stationary theory that ought to bear the blame of the absence of those grounds: and yet more the retrograde, which is chargeable with urging the restoration of the same wornout principles which, by their decrepitude, have caused all this anarchy. The stationary school does not want to hear of any such principles, and interdicts them; and the retrograde school insists that the old ones will do over again. So that, if the revolutionary school first encouraged the anarchy, the other two protract it.

Of all questions, there are none which have so much claim as social problems to be consigned to a small number of choice minds which shall have been prepared by a high order of discipline and instruction for the investigation of questions so complex and so mixed up with human passions. Such is, at least, the natural state of the human mind, in contrast with which its condition in revolutionary periods may be regarded as, in a manner, pathological, however inevitable. The social malady must be very serious when we see all manner of persons, however inferior their intelligence, and however unprepared, stimulated, in the highest manner, and from day to day, to cut the knot of the most intricate political questions, without any guidance or restraint. The wonder is, not that the divergence of opinion is what it is, but that any points of agreement at all are left amid all this dissolution of social maxims. The evil has reached such a point that all political opinions, though of course derived from one of the three schools, differ through so many degrees as to become individual; through all degrees, in fact, that the combination of three orders of vicious principles admits of. Except on occasion of emergency, when there is a temporary coalition (amid which each one usually hopes to have his own way) it becomes more and more difficult to make even a very small number of minds adhere to a plain and explicit profession of political faith. This inability to co-operate prevails in all the three camps—as we ought carefully to observe: and each party has often, in its ingenuous moments, bitterly deplored the intense disagreement with which it supposed itself to be especially afflicted; whereas, the others were no better organized; and the chief difference in the three cases was that each was most acutely sensible of its own misery.

In countries where this intellectual anarchy has been sanctioned by the political preponderance of Protestantism, the divergences have been more multiplied than elsewhere, without being less serious. It could not but be so from the tendency of the general mind, in its then infantile state, to use its new emancipation to plunge into the indefinite discussion of religious opinions—(the most vague and discordant of all)—in the absence of a restraining spiritual authority. In the United States, for instance, there are hundreds of Christian sects, radically discordant, and incessantly parting off into opinions which are really little more than individual, which it is impossible to classify, and which are already becoming implicated with innumerable political differences. The nations which, like the French, have escaped the treacherous stage of Protestantism, and have passed at once from the Catholic to the fully revolutionary state, were not, on that account, entirely exempt from the intellectual anarchy inherent in any prolonged exercise of the absolute right of free individual inquiry. All that can be said is that their aberrations, without being less anti-social, have a less vague character, and are less in the way of the final reorganization. They arise, take possession for awhile of even healthy and well-trained intellects, and then give place to others that have their day, and in their turn are superseded. In our time, we hear of proposals, entertained here and there even by men who know what positive science is in some one department of study, which it is a shock to one's hopes to see so advocated; proposals, for instance, to abolish money and recur to a state of barter; to destroy the great capitals in order to restore rural innocence; to have a fixed rate of wages, and the same rate for every kind of labor, and so forth. Such opinions are daily given out, side by side with those which are the most philosophical and the most carefully elaborated; and none have any chance of being established under the rule of any intellectual discipline whatever, though the wise are compromised with the foolish in the eyes of public reason. The inevitable result of such a chronic epidemic is the gradual destruction of the public *morale*, which is not sustained, among the generality of men, so much by the direct sentiment as by habit, guided by the uniform assent of individual wills to invariable and general rules, adapted to fix, on every serious occasion, the true idea of the public good. So complex is the nature of social questions that there is much that is to be said on all sides; and there is no institution, however indispensable, which does not involve serious and numerous inconveniences, more or less partial and transient; and, on the other hand, there is no Utopia so wild as not to offer some incontestable advantages; and few are the minds which are not so preoccupied by ideas, or stimulated by passion, as to be able to contemplate at once all the aspects of any social subject. Thus it is that almost all the great maxims of public morality are condemned on account of their salient faults, while their determining grounds are hidden till exhibited by an exact analysis, which must in many cases be extremely delicate. Thus again, it is that all true moral order is incompatible with the existing vagabond liberty of individual minds, if such license were to last; for the great social rules which should become customary can not be abandoned to the blind and arbitrary decision of an incompetent public without losing all their efficacy. The requisite convergence of the best minds can not be obtained without the voluntary renunciation, on the part of most of them, of their sovereign right of free inquiry, which they will doubtless be willing to abdicate, as soon as they have found organs worthy to exercise appropriately their vain provisional supremacy. If it is so in problems of science, there is every reason to expect it in the more difficult questions of social principle. Meanwhile, all vague notions of public good, degenerating into an indistinct philanthropy, must succumb to the energetic forces of a highly-stimulated selfishness. In the daily course of our political conflicts we see accordingly the most conscientious men taxing each other with wickedness and folly; and, on every serious occasion, the most opposite doctrines maintained by persons equally worthy of confidence: and, while all deep and steady conviction is thus rendered impossible, no true political morality can be hoped for by those who desire it most.

Destruction of public morality.

This public demoralization has, it must be admitted, been sensibly retarded, in our time, by the preponderance of that revolutionary doctrine which has borne the imputation of causing it; for the revolutionary party, progressive in character, could not but be animated, more than the others, by sincere convictions, which, in their depth and activity, must tend to restrain, and even annihilate, individual selfishness. This was especially remarkable during the season when the revolutionary doctrine was, by a general illusion, supposed to be destined to reorganize society. Under the impulse of this persuasion, the strongest social devotedness that can shed honor upon contemporary history was manifested. But this could be only for a time. As the illusion disappeared, the convictions which arose from it became first weakened, and then mingled with the influences of the stationary, and even the retrograde polity: and though they are still of a higher order than those which are inspired by the other doctrines, and especially among the young, they have not energy to resist the dissolving action of the revolutionary philosophy, even among its own advocates; so that this philosophy now contributes, almost as much as its two antagonists, to the spread of political demoralization.

Private morality.

Private morality is, happily, much less dependent on established opinions. Other conditions enter into this case; and in the commonest questions, natural sentiment is far more operative than in public relations. Disorganizing influences are strongly counteracted by the continuous amelioration of our manners, through a more equitable intellectual development, by a juster sense and more familiar taste for the various fine arts, and by the gradual improvement of social condition in consequence of steady industrial progress. The common rules of domestic and personal morality have guarded private life longer than political from the invasion of disorganizing influences, and the intrusion of individual analysis. But the time has arrived for these inevitable disturbances, long concealed, to manifest their dangerous activity. So long ago as the first rise of the revolutionary state, this deleterious influence on morality, properly so called, began with a serious innovation on the institution of Marriage, which would have been radically changed, by the permission of divorce in Protestant countries, if public decency and private good sense had not, up to this time, weakened the pernicious effects of theologico-metaphysical extravagances. Still, private morality could be reached only through the destruction of political morals; and now, that barrier being broken through, the dissolving action threatens domestic, and even personal morality, which is the necessary foundation of every other. Whichever way we look at it, whether as to the relations of the sexes, to those of ages, or of conditions, it is clear that the elements of all social life are directly compromised by a corrosive discussion which is not directed by true principles, and which brings into question, without the possibility of solution, even the least important ideas of duty. Even the Family, which, amidst the fiercest revolutionary tumults, had been on the whole respected, has been assailed in our day in its very foundations, by attacks on the hereditary principle and on marriage. We have even seen the commonest principle of personal morality, the subjection of the passions to reason, denied by pretended reformers who, in defiance of all experience and such positive science as we have, have proposed as a fundamental dogma of their regenerated morality, the systematic dominion of the passions, which they have striven, not to restrain, but to excite by the strongest stimulants. These speculations have so far penetrated social life, that any one is now at liberty to make an easy merit of the most turbulent passions; so that, if such license could last, insatiable stomachs might at length get to pride themselves on their own voracity. It is in vain for the retrograde school to throw the blame of all this on the revolutionary school. The censure rests upon themselves, inasmuch as they have persisted in extolling, as the only intellectual bases of social duty, principles which have betrayed their impotence in this very case; for, if theological conceptions are, in truth, the immutable bases of future as well as past morality, how is it that they now fail to obviate such license? What are we to think of the attempt to shore up by laborious artifices, the religious principles which are proposed, after they have lost their strength, as the only supports of moral order? No supreme function can be assigned to convictions that have themselves given way before the development of human reason, which is not likely to use its mature power to reconstruct the bonds which it broke through in the efforts of its youth. It is remarkable that the license I have spoken of has been proposed by the ardent restorers of religious theories, in their exasperation against all positive philosophy; and this has, for some time past, been the case with Protestant, no less than Catholic advocates. So far from furnishing bases for morality, domestic or personal, religious convictions have long tended to its injury, both by hindering its erection on more solid foundations among those who are free from their control, and by being insufficient for their own subjects, without the active intervention of a sacerdotal authority; that authority meanwhile perpetually losing its hold over the more advanced populations, and being more and more absorbed by the care of its own preservation, instead of venturing upon any unpopular scheme of discipline. Daily experience shows that the ordinary morality of religious men is not, at present, in spite of our intellectual anarchy, superior to that of the average of those who have quitted the churches. The chief practical tendency of religious conviction is, in our present social life, to inspire an instinctive and insurmountable hatred against all who have emancipated themselves, without any useful emulation having arisen from the conflict. Thus the chief assaults, direct and indirect, on private as well as public morality, are as strictly imputable to the stationary, and yet more to the retrograde, than to the revolutionary philosophy, which is commonly made to bear all the blame. It is, indeed, but too evident that the three doctrines are almost equally powerless to restrain the development of individual selfishness, which grows bolder, from day to day, in clamoring for the license of the least social passions, in the name of universal intellectual anarchy.

Political corruption.

The second characteristic of our condition follows from the first. It is the systematic corruption which is set up as an indispensable instrument of government. The three doctrines bear their share, though it may be an unequal one, in this disgraceful result, because all exclude, as we have seen, true political convictions. Amidst the absence or the discredit, of general ideas, which have now no power to command genuine acts, there is no other daily resource for the maintenance of even a rough and precarious order than an appeal, more or less immediate, to personal interests. Such an influence is scarcely ever needed with men of deep convictions. Even in the lower order of characters, human nature is rarely so debased as to allow a course of political conduct in opposition to any strong convictions; and such contrariety, if persevered in, would soon paralyze the faculties. In the scientific class, in which philosophical convictions are at present most common and best marked, active corruption is scarcely practicable, though minds are there much of the same quality as they are elsewhere. Thus, exceptional cases apart, the rapid spread of a corruption which avails itself of the half-convictions that are prevalent in the political world must be attributed mainly to the undecided and fluctuating state in which social ideas are kept by the intellectual anarchy of our time. Not only does this disorder of minds permit the political corruption: it even requires it, as the only means of obtaining any sort of practical convergence, such as is necessary for the mere preservation of the social state in its grossest interests: and we must prepare ourselves for the continuous extension of the evil, as long as intellectual anarchy goes on destroying all strong political conviction. Rulers and the ruled are alike guilty in regard to this vice: the rulers by their disdain of all social theory; by their repression of mind, and by their application of the instrument which they can not dispense with to their own, instead of the general interest; and the ruled by their acceptance of the proffered corruption, and by their intellectual condition rendering the use of it inevitable. If individuals can not co-operate on any other ground than that of private interest, they have no right to complain that governments take the same ground to procure the assistance that they can not dispense with, during a period in which it is scarcely possible to see clearly what the public good really consists in. All that can be said for such a state of things is that matters would be worse if individual eccentricities were not somewhat restrained by personal interest, in the absence of better influences; and that it is the natural result of the situation to which it applies, and therefore certainly destined to disappear whenever society shall begin to admit of a better discipline. Till then we must expect to see this miserable expedient more and more resorted to; as is proved by the constant experience of all peoples living under a prolonged constitutional or representative *régime*, as we now call it, always compelled to organize in this manner a certain material discipline in the midst of a complete intellectual, and therefore moral anarchy. All that we have a right to require is that governments, instead of welcoming this disastrous necessity, and making an eager use of the facilities it offers, should set themselves to favor, systematically, by all the means at their command the great philosophical elaboration through which modern society may enter upon a better course.

By corruption, I do not mean only direct venality, nor yet the holding of honorary distinctions which are merely flattering to the vanity. The scope offered to various kinds of ambition is a more corrupting influence. In some countries this had been carried so far, in the form of creation of offices, that nations are farmed by the functionaries of their governments. The danger of such a course is obvious enough; for the number of aspirants, where offices are very numerous, must always largely exceed that of the chosen; and their disappointment must awaken passions anything but favorable to the establised *régime*. Moreover, the practice must spread the more it is resorted to; and it will go on extending till the time for social reorganization has arrived. Here, again, all the three schools must share the blame. The Revolutionary school supplied, as we have seen, the dissolving influence which rendered the system of corruption necessary. The Stationary school even sets it up as a type, declaring the equal admission of all the public functions to be the final destination of the general social movement; and aggravating the case by connecting the conditions of order with the mere possession of fortune, however obtained. As for the Retrograde school, with all its pretensions to moral purity, it employs corruption as fatally as the other two, under the special form which it appropriates,—that of the systematic hypocrisy. From the opening of the revolutionary period, in the sixteenth century, this system of hypocrisy has been more and more elaborated in practice, permitting the emancipation of all minds of a certain bearing, on the tacit condition that they should aid in protracting the submission of the masses. This was, eminently, the policy of the Jesuits. Thus has the retrograde school suffered under this vice as early as the others; and it can not but resort to corruption more and more, in proportion to its own opposition to the general movement of the society which it pretends to rule.

This, then, is our state. For want of a moral authority, material order requires the use of either terror or corruption; and the latter is both more durable, less inconvenient, and more accordant with the nature of modern society than the former. But, while admitting the inevitable character of the evil, it is impossible not to lament, bitterly and mournfully, the blindness which prevents the social powers of our time from facilitating to the utmost the philosophical evolution by which alone we can issue into a better state. It seems as if statesmen of all parties were agreed to close this sole avenue of safety by visiting with stupid reprobation all elaboration of social theories. This again, however, is only another consequence of the present state of the most civilized nations; and, as a consequence, not less necessary or characteristic than those that have gone before.

Low aims of political questions.

Fatal to Progress.

The third symptom of our social situation is the growing preponderance of material and immediate considerations in regard to political questions. There is something more concerned here than the ordinary antagonism between theory and practice, aggravated by the weakness of attempts at theory in an infantile period of social science. The repugnance to theory is further attributable to the historical circumstances that when, three centuries ago, the spiritual power was finally annulled or absorbed by the temporal, all lofty social speculations were more and more devolved upon minds which were always pre-occupied by practical affairs. Thus kings and their peoples concurred in exalting the lower order of considerations; and the tendency belonged to all the three schools of polity. If the crowning evil of our time be its intellectual anarchy, it is clear that we can not too strongly lament this irrational unanimity of the political world in closing the path of progress by proscribing speculative researches. We see the consequences in our experience of the past century. In seeking social reorganization, men have not first looked to the doctrines of a new social order, and then to the corresponding manners; but have gone straight to the construction of institutions, at a time when we have all possible evidence that institutions can be nothing more than provisional, restricted to the most indispensable objects, and having no other relation to the future than such facility as they may afford to the process of political regeneration. The making of institutions in our day consists in parcelling out the old political powers, minutely organizing factitious and complex antagonisms among them, rendering them more and more precarious by submitting them to election for terms; but in no way changing either the general nature of the ancient *régime* or the spirit which worked it. For want of all social doctrine, nothing more has been attempted than restraining the powers thus preserved, till there is every danger of their being altogether annulled, while the principles which were to direct their application were left doubtful and obscure. The pompous name of a Constitution is then given to this piece of work, and it is consecrated to the eternal admiration of posterity. Though the average duration of these constitutions has been at most ten years, each new system, set up on the very ground of the failure of the last, has claimed, under pains and penalties, a general faith in its absolute and indefinite triumph. The only action of such institutions is in preventing all social reorganization by fixing minds on puerile questions of political forms, and by interdicting speculations and philosophical discussion which would disclose the principles of reorganization. By this action, the character of the disease has been concealed as much as possible, and any gradual and specific cure has been almost impracticable. It is strange that minds should be so self-deceived as to disclaim all speculative prejudices while they propose the most absurd of all political Utopias,—the construction of a system of government which rests upon no true social doctrine. Such an absurdity is referrible to the cloudy prevalence of the metaphysical philosophy, which perverts and confuses men's notions in politics, as it did formerly, during its short triumph, in all other orders of human conceptions.

Fatal to Order.

It is not only as an impediment to progress that the preponderance of material conceptions is to be deplored. It is dangerous to order. When all political evils are imputed to institutions instead of to ideas and social manners, which are now the real seat of the mischief, the remedy is vainly sought in changes, each more serious than the last, in institutions and existing powers. The failure of the last change is forgotten; and hopes are concentrated on the next, showing how ineffectual are the lessons of experience when the results are not elucidated by a rational analysis. Such changes must occur, in our progress to a better state. What it is fair to require in regard to them is that they should be recognized as provisional, and be guided by some philosophical consideration of the social question at large. Another consequence of the prevalent preference of institutions to doctrines is, besides its prematurity, its engendering errors of the most serious kind, and of a permanent character, by including in the domain of temporal government what belongs to the spiritual. For their neglect of this grand distinction, the various governments of Europe have been punished by becoming responsible for all the evils of society, whencesoever they might have arisen. The illusion is yet more injurious to society itself through the disturbances and mortifications which it induces. An illustration of the case is presented by the discussions and attacks which have so often menaced the institution of Property. It is impossible to deny that, when all exaggerations are stripped away, an unquestionable amount of evil remains in connection with property, which ought to be taken in hand, and remedied, as far as our modern social state permits. But it is equally evident that the remedy must arise from opinions, customs, and manners, and that political regulations can have no radical efficacy; for the question refers us to public prepossessions and usages which must habitually direct, for the interest of society, the exercise of property, in whose hands soever it may be lodged. We may see here how futile and how blind, and also how disturbing, is this tendency to refer everything to political institutions, instead of fixing expectation on an intellectual and moral reorganization.

Thus we proceed, securing neither order nor progress, while we consider our sufferings to be of a physical, whereas they are really of a moral nature. Modifications of ancient systems have been tried, and have given no relief; and our ideas of political progress are narrowing down to that of a substitution of persons,—the most disgraceful political degradation of all, because, directed by no plan, it tends to subject society to an interminable series of catastrophes. The material order, which is all that is contemplated, is confided to a power which is regarded as hostile, and perpetually enfeebled by a systematic antagonism. The restricted view of each of the agents of such a mechanism prevents their co-operation, except under the immediate alarm of material anarchy, when they suspend their useless controversies till the storm has blown over, when they go on as before, till some catastrophe ensues, taking everybody by surprise, though any one might have foreseen it. In this discarding of social speculation for the sake of material and immediate considerations, we see a fresh indication that intellectual anarchy is the main cause of our social maladies.

Incompetence of political leaders.

A fourth characteristic of our social condition is a natural consequence and complement of the preceding; the incompetence of the minds which occupy the chief political stations, during such a condition of affairs, and even their antipathy to a true reorganization: so that a final, and not less disastrous illusion of modern society is that the solution of the problem may be looked for from those who can do nothing but hinder it. From what we have already seen, we must be aware that the gradual demolition of all social maxims, and, at the same time, the attenuation of political action, must tend to remove elevated minds and superior understandings from such a career, and to deliver over the political world to the rule of charlatanism and mediocrity. The absence of any distinct and large conception of a social future is favorable to the more vulgar forms of ambition; and presumptuous and enterprising mediocrity has never before had so fortunate a chance. While social principles are not even sought, charlatanism will always attract by the magnificence of its promises; and its transient successes will dazzle society, while in a suffering condition, and deprived of all rational hope. Every impulse of noble ambition must turn the best men away from a field of action where there is no chance of scope and permanence, such as are requisite to the carrying out of generous schemes. It is, as M. Guizot has well said, a social period when *men will feebly, but desire immensely*. It is a state of half-conviction and half-will, resulting from intellectual and moral anarchy, offering many obstacles to the solution of our difficulties. It is important, however, not to exaggerate those obstacles. This very state of half-conviction and half-will tends to facilitate by anticipation the prevalence of a true conception of society which, once produced, will have no active resistance to withstand, because it will repose on serious convictions: and at present, the dispersion of social interests tends to preserve the material order which is an indispensable condition of philosophical growth. It would be a mere satirical exaggeration to describe existing society as preferring political quackery and illusion to that wise settlement which it has not had opportunity to obtain. When the choice is offered, it will be seen whether the attraction of deceptive promises, and the power of former habit, will prevent our age from entering, with ardor and steadiness, upon a better course.

There are evident symptoms that the choice will be a wise one, though the circumstances of the time operate to place the direction of the movement in hands which are anything but fittest for the purpose. This inconvenience dates from the beginning of the revolutionary period, and is not a new, but an aggravated evil. For three centuries past, the most eminent minds have been chiefly engaged with science, and have neglected politics; thus differing widely from the wisest men in ancient times, and even in the Middle Ages. The consequence of this is that the most difficult and urgent questions have been committed to the class which is essentially one under two names,—the civilians and the metaphysicians, or, under their common title, the lawyers and men of letters, whose position in regard to statesmanship is naturally a subordinate one. We shall see hereafter that, from its origin to the time of the first French Revolution, the system of metaphysical polity was expressed and directed by the universities on the one hand, and the great judiciary corporations on the other: the first constituting a sort of spiritual, and the other the temporal power. This state of things is still traceable in most countries of the continent; while in France, for above half a century, the arrangement has degenerated into such an abuse that the judges are superseded by the bar, and the doctors (as they used to be called) by mere men of letters; so that now, any man who can hold a pen may aspire to the spiritual regulation of society, through the press or from the professional chair, unconditionally, and whatever may be his qualifications. When the time comes for the constitution of an organic condition, the reign of sophists and declaimers will have come to an end: but there will be the impediment to surmount of their having been provisionally in possession of public confidence.

The survey that we have made must convince us only too well of the anarchical state of existing society, under its destitution of guiding and governing ideas, and amid its conflict of opinions and passions, which there is no power in any of the three schools to cure or moderate. As preliminary considerations, these facts are deeply disheartening; and we can not wonder that some generous and able but ill-prepared minds should have sunk into a kind of philosophical despair about the future of society, which appears to them doomed to fall under a gloomy despotism or into mere anarchy, or to oscillate between the two. I trust that the study we are about to enter upon will give rise to a consoling conviction that the movement of regeneration is going on, though quietly in comparison with the apparent decomposition, and that the most advanced of the human race are at the threshold of a social order worthy of their nature and their needs. I shall conclude this introduction by showing what must necessarily be the intellectual character of the salutary philosophy which is to lead us into this better future: and its dogmatic exposition will follow in the next chapters.

Advent of the Positive Philosophy. The preliminary survey which I have just concluded led us necessarily into the domain of politics. We must now return from this excursion, and take our stand again at the point of view of this whole Work, and contemplate the condition and prospects of society from the ground of positive philosophy. Every other ground has been found untenable. The theological and metaphysical philosophies have failed to secure permanent social welfare, while the positive philosophy has uniformly succeeded, and conspicuously for three centuries past, in reorganizing, to the unanimous satisfaction of the intellectual world, all the anterior orders of human conceptions, which had been till then in the same chaotic state that we now deplore, in regard to social science. Contemporary opinion regarded the state of each of those sciences as hopeless till the positive philosophy brought them out of it. There is no reason why it should fail in the latest application, after having succeeded in all the earlier. Advancing from the less complex categories of ideas to the more complex and final one, and comparing with this experience the picture just given of our present social condition, we can not but see that the political analysis and the scientific concur in demonstrating that the positive philosophy, carried on to its completion, is the only possible agent in the reorganization of modern society. I wish to establish this principle first, and in this place, apart from all considerations about my way of proving my point; so that, if my attempt should be hereafter condemned, no unfavorable inference may be drawn in regard to a method which alone can save society, and that public reason should have nothing to do but to require from happier successors more effectual endeavors in the same direction. In all cases, and especially in this, the method is of even more importance than the doctrine: and it is for this reason that I think it right, before closing my long introduction, to offer, in a brief form, some last prefatory considerations.

This is not the place in which to enter upon any comparison between the positive political philosophy and the other social theories which have been tried; but, while still deferring the scientific appreciation of the positive method, and before quitting the political ground on which I have, for the occasion, taken my stand, I must point out in a direct and general way, the relation of the positive philosophy to the two great necessities of our age.

Logical coherence of the doctrine.

The ascendancy of a positive social doctrine is secured by its perfect logical coherence in its entire application—a characteristic property which enables us at once to connect the political with the scientific point of view. The positive polity will embrace at once all the essential aspects of the present state of civilization, and will dissolve the deplorable opposition that now exists between the two orders of social needs, the common satisfaction of which will henceforth depend on the same principle. It will impart a homogeneous and rational character to the desultory politics of our day, and it will by the same act connect this co-ordinated present with the whole past, so as to establish a general harmony in the entire system of social ideas, by exhibiting the fundamental uniformity of the collective life of humanity; for this conception can not, by its nature, be applied to the actual social state till it has undergone the test of explaining, from the same point of view, the continuous series of the chief former transformations of society. It is important to note this difference between the positive principle and that of the two other schools. The critical school treats all times prior to the revolutionary period with a blind reprobation. The retrograde school equally fails in uniting the present with the past, and uniformly disparages the position of modern society during the last three centuries. It is the exclusive property of the positive principle to recognize the fundamental law of continuous human development, representing the existing evolution as the necessary result of the gradual series of former transformations, by simply extending to social phenomena the spirit which governs the treatment of all other natural phenomena. This coherence and homogeneousness of the positive principle is further shown by its operation in not only comprehending all the various social ideas in one whole, but in connecting the system with the whole of natural philosophy, and constituting thus the aggregate of human knowledge as a complete scientific hierarchy. We shall see hereafter how this is accomplished, and I mention it now to show how the positive philosophy, finding thus a general fulcrum in all minds, can not but spread to a universal extension. In the present chaotic state of our political ideas, we can scarcely imagine what must be the irresistible energy of a philosophical movement, in which the entire renovation of social science will be directed by the same spirit which is unanimously recognized as effectual in all other departments of human knowledge. Meantime, it finds some points of contact in the most wilful minds, whence it may proceed to work a regeneration of views. It speaks to every class of society, and to every political party, the language best adapted to produce conviction, while maintaining the invincible originality of its fundamental character. It alone, embracing in its survey the whole of the social question, can render exact justice to the conflicting schools, by estimating their past and present services. It alone can exhibit to each party its highest destination, prescribing order in the name of progress, and progress in the name of order, so that each, instead of annulling, may strengthen the other. Bringing no stains from the past, this new polity is subject to no imputation of retrograde tyranny, or of revolutionary anarchy. The only charge that can be brought against it is that of novelty; and the answer is furnished by the evident insufficiency of all existing theories, and by the fact that for two centuries past its success has been uniform and complete, wherever it has been applied.

Its effect on Order.

As to its operation upon Order, it is plain that true science has no other aim than the establishment of intellectual order, which is the basis of every other. Disorder dreads the scientific spirit even more than the theological, and, in the field of politics, minds which rebelled against metaphysical hypotheses and theological fictions submit without difficulty to the discipline of the positive method. We even see that while the mind of our day is accused of tending toward absolute skepticism, it eagerly welcomes the least appearance of positive demonstration, however premature and imperfect. The eagerness would be full as great if the idea were once formed that social science might also be conducted by the positive spirit. The conception of invariable natural laws, the foundation of every idea of order, in all the departments, would have the same philosophical efficacy here as elsewhere, as soon as it was sufficiently generalized to be applied to social phenomena, thenceforth referred, like all other phenomena, to such laws. It is only by the positive polity that the revolutionary spirit can be restrained, because by it alone can the influence of the critical doctrine be justly estimated and circumscribed. No longer roused to resistance, as by the retrograde school, and seeing its work done better than by itself, it will merge in a doctrine which leaves it nothing to do or to desire. Under the rule of the positive spirit, again, all the difficult and delicate questions which now keep up a perpetual irritation in the bosom of society, and which can never be settled while mere political solutions are proposed, will be scientifically estimated, to the great furtherance of social peace. By admitting at once that the institutions of moder societies must necessarily be merely provisional, the positive spiri will abate unreasonable expectations from them, and concentrate effort upon a fundamental renovation of social ideas, and consequently of public morals. Instead of indifference being caused by this carrying forward of political aims, there will be a new source of interest in so modifying modern institutions as to make them contributory to the inevitable intellectual and moral evolution. At the same time, it will be teaching society that, in the present state of their ideas, no political change can be of supreme importance, while the perturbation attending change is supremely mischievous, in the way both of immediate hinderance and of diverting attention from the true need and procedure. And again, order will profit by the recognition of the relative spirit of the positive philosophy, which discredits the absolute spirit of the theological and metaphysical schools. It can not but dissipate the illusion by which those schools are for ever striving to set up, in all stages of civilization, their respective types of immutable government; as when, for instance, they propose to civilize Tahiti by a wholesale importation of Protestantism and a Parliamentary system. Again, the positive spirit tends to consolidate order, by the rational development of a wise resignation to incurable political evils. Negative as is the character of this virtue, it affords an aid under the pains of the human lot which can not be dispensed with, and which has no place under the metaphysical polity, which regards political action as indefinite. Religious, and especially Christian resignation is, in plain truth, only a prudent temporizing, which enjoins the endurance of present suffering in view of an ultimate ineffable felicity. A true resignation—that is, a permanent disposition to endure, steadily, and without hope of compensation, all inevitable evils, can proceed only from a deep sense of the connection of all kinds of natural phenomena with invariable laws. If there are (as I doubt not there are) political evils which, like some personal sufferings, can not be remedied by science, science at least proves to us that they are incurable, so as to calm our restlessness under pain by the conviction that it is by natural laws that they are rendered insurmountable. Human nature suffers in its relations with the astronomical world, and the physical, chemical, and biological, as well as the political. How is it that we turbulently resist in the last case, while, in the others, we are calm and resigned, under pain as signal and as repugnant to our nature? Surely it is because the positive philosophy has as yet developed our sense of the natural laws only in regard to the simpler phenomena; and when the same sense shall have been awakened with regard to the more complex phenomena of social life, it will fortify us with a similar resignation, general or special, provisional or indefinite, in the case of political suffering. An habitual conviction of this kind can not but conduce to public tranquillity, by obviating vain efforts for redress, while it equally excludes the apathy which belongs to the passive character of religious resignation, by requiring submission to nothing but necessity, and encouraging the noblest exercise of human activity, wherever the analysis of the occasion opens any prospect whatever of genuine remedy. Finally, the positive philosophy befriends public order by bringing back men's understandings to a normal state through the influence of its method alone, before it has had time to establish any social theory. It dissipates disorder at once by imposing a series of indisputable scientific conditions on the study of political questions. By including social science in the scientific hierarchy, the positive spirit admits to success in this study only well-prepared and disciplined minds, so trained in the preceding departments of knowledge as to be fit for the complex problems of the last. The long and difficult preliminary elaboration must disgust and deter vulgar and ill-prepared minds, and subdue the most rebellious. This consideration, if there were no other, would prove the eminently organic tendency of the new political philosophy.

Its effect on Progress.

I have dwelt on this influence of the Positive philosophy, in favor of Order, because it is that which is, as yet, least recognised, while the retrograde and stationary schools continue to found their claims upon that very point. There is less mistake about its favorable influence on Progress. In all its applications, the positive spirit is directly progressive; its express office being to increase our knowledge, and perfect the connection of its parts. Even the illustrations of progression are, at the present day, derived from the positive sciences. Whatever rational idea of social progress (that is, of continuous development, with a steady tendency toward a determinate end) anywhere exists, should, as we shall hereafter see, be attributed to the unperceived influence of the positive philosophy, in disengaging this great notion from its present vague and fluctuating state by clearly assigning the aim and the general course of progress. Though Christianity certainly bore a part in originating the sentiment of social progress by proclaiming the superiority of the new law to the old, it is evident that the theological polity, proceeding upon an immutable type, which was realized only in the past, must have become radically incompatible with ideas of continuous progression, and manifests, on the contrary, a thoroughly retrograde character. The metaphysical polity, in its dogmatic aspect, has the same incompatibility, though the feeble connection of its doctrines renders it more accessible to the spirit of our time. Indeed, it was only after the decline of that school had begun, that ideas of progress took any general possession of the public mind. Thus the progressive, as well as the organic instinct, is to be developed by the positive philosophy alone.

The only idea of progress which is really proper to the revolutionary philosophy, is that of the continuous extension of liberty; that is, in positive terms, the gradual expansion of human powers. Now, even in the restricted and negative sense in which this is true—that of the perpetual diminution of obstacles—the positive philosophy is incontestably superior; for true liberty is nothing else than a rational submission to the preponderance of the laws of nature, in release from all arbitrary personal dictation. Decisions of sovereign assemblies have been called laws by the metaphysical polity, and have been fictitiously regarded as a manifestation of popular will. But no such homage paid to constitutional entities can disguise the arbitrary tendency which marks all the philosophies but the positive. The arbitrary can never be excluded while political phenomena are referred to Will, divine or human, instead of being connected with invariable natural laws; and liberty will remain illusory and precarious, notwithstanding all constitutional artifices, and whatever be the will to which we pay our daily obedience. By substituting the empire of genuine convictions for that of arbitrary will, the positive philosophy will put an end to the absolute liberty of the revolutionary school—the license of running from one extravagance to another—and, by establishing social principles, will meet the need at once of order and of progress. The special office of the revolutionary philosophy, that of extinguishing all but the historical existence of the ancient political system, is virtually committed to the positive principle; and, in fact, the power exercised by the critical doctrine in this direction has been owing to its serving the purpose of a provisional organ to the positive philosophy. In other sciences, the critical action, however energetic, is only a collateral consequence of its organic development; and the organic development which is fatal to the old theological system, involves in the same condemnation the metaphysical spirit, which is even the less logical of the two. The most serious difficulty of contemporary politics is the condition of the lower classes; and in this case the positive philosophy affords practical amelioration most favorable to progress. The revolutionary polity opened only an insurrectionary issue to this difficulty, and merely shifted without solving the question. The question is not settled by opening a way to popular ambition, the gratification of which must be confined to a few (probably deserters from their class), and can do nothing to soothe the murmurs of the multitude. The general lot is even aggravated by the excitement of unreasonable hopes, and by the elevation of a few by the chances of the political game. As it is the inevitable lot of the majority of men to live on the more or less precarious fruits of daily labor, the great social problem is to ameliorate the condition of this majority, without destroying its classification, and disturbing the general economy: and this is the function of the positive polity, regarded as regulating the final classification of modern society. We shall have occasion to see hereafter that the mental reorganization, by habitually interposing a common moral authority between the working classes and the leaders of society, will offer the only regular basis of a pacific and equitable reconciliation of their chief conflicts, nearly abandoned in the present day to the savage discipline of a purely material antagonism.

In this brief sketch of the prominent characteristics of the positive polity, we have seen that, notwithstanding its severe estimate of the different existing parties, it commands access to the spirit of each by proving itself adapted to fulfil the aims which each has pursued too exclusively. It can also turn to the profit of its gradual ascendency all the important incidents of existing society which it could not intercept. Whether in its hour of exultation, the one school manifests its insufficiency; or whether, in the despair of failure, the other shows a disposition to welcome new means of political action; or whether, again, a kind of universal torpor exhibits in its nakedness the aggregate of social needs, the new philosophy can always lay hold of a certain general issue to introduce, by a daily application, its fundamental instruction. In doing this, however, we must, it seems to me, lay aside all hope of a real conversion of the retrograde school. Setting aside some happy individual anomalies, such as always exist, and may become more frequent, it remains indisputable that there is such an antipathy in regard to social questions, between the theological and the positive philosophies, that the one can never estimate the other, and must disappear before it, without being able to undergo any radical modification of its present form. It is, in fact, not Order that the ancient *régime* aims at, but only its own preconception of a unique order, connected with its habits of mind and special interests, outside of which everything appears disorderly, and therefore indifferent. In the midst of its pretended devotion to general order, the retrograde school has often betrayed its tendency to care for the means more than the end. It is through the stationary school, whose love of order is at least more impartial, if not more disinterested, that the positive polity must obtain the access which it could not hope for from the retrograde school. The metaphysical fictions of the parliamentary or constitutional philosophy may have diverted the mind of the stationary school from the true issue ; but they have not attained such an ascendency among the nations of the European continent as to render them deaf to the rational voice of the new philosophy, when it appeals to a school so openly disposed as is the stationary party to establish permanent order, on whatever principles, in modern society. Some useful action may therefore be hoped for through this medium. Nevertheless, I avow that it is on the revolutionary school alone that, in my opinion, we can expect that the positive polity can exercise a predominant influence, because this school is the only one that is always open to new action on behalf of progress. All its indispensable provisional doctrines will be absorbed by the new philosophy, while all its anarchical tendencies will be extinguished. There will be more explosions of revolutionary doctrine, as long as there are any remains of the retrograde system ; for the natural course of events does not wait for our slow philosophical preparation. Whether in virtue of our intellectual condition, or of faults committed by existing governments, such outbreaks will occur ; and perhaps they may be necessary to the uprooting of all hope of reconstructing social order on the old basis ; but the positive philosophy will have foreseen such conflicts, and will take no part in them, further than to make use of the instruction that they afford. It will not interfere with the last operations of the revolutionary preponderance—knowing that they are the last. Nor will it paralyse so important a general disposition as that which constitutes the critical spirit, properly so called. By subordinating it for ever to the organic spirit, it will open to it broad political aims ; it will afford it employment in destroying all metaphysical and theological interference, using for this end the satirical faculties which produced nothing in the last century, but which may be of a secondary value in influencing the development of the political character that will be finally assigned to each school. On the whole, we may hope that the positive philosophy will find grounds of support among the most advanced sections of the revolutionary school ; and, whatever may be the hopes of that school from different political parties, it will be unable to dispense with the scientific superiority of the positive doctrine, which is the certain cause and guarantee of its gradual ascendency.

Anarchical tendencies of the scientific class.

It might have been hoped that the renovation we are anticipating would have been largely aided by the scientific class of society, as that which must be most familiar with positive science. But it is not so. At present, the anarchical tendencies of that class appear to be as strong as any. The indifference of scientific men to the most interesting and most urgent of all classes of problems may be partly accounted for by their deep intellectual disgust at the irrational character of the social doctrines of their day; but there are other reasons, even less honorable than this. They are themselves defective in scientific discipline. They abhor generalities, and have a systematic predilection for specialities. Under the idea of an organization of labor, they restrict their several pursuits within the narrowest bounds, without providing for the investigation of general relations; and thus, science becomes a pastime, grounded on no adequate preparation. It is not wonderful then that they have no interest in the entire generality which is the indispensable attribute of any philosophy that aspires to the moral government of mankind. Daily experience shows that, when learned bodies are brought into junction, for any political purpose, with sensible men who know nothing of science, but are accustomed to general views, the superiority rests with the latter, even in regard to matters which particularly concern the scientific class. As long as this is the case, the scientific class decrees its own political subordination. Their social sentiment is on a par with their ideas; and their egotism is aggravated by their devotion to specialities, when it ought to be subdued by a mastery of positive science; and would be so, if they could admit its general ideas. This is no fault of individuals among them. It is imputable to the defective scientific education of our time; and all that men of science are censurable for is their dogmatic denial of the need of a better. We must, however, abandon all hope of their co-operation in extending the positive method to the study of social phenomena. If we may anticipate anything in that direction, it must be from a rising generation for whom a more adequate training must be provided, and who will be led by a really scientific education beyond the special and isolated studies to which they now conceive themselves to be destined, and which constitute at present their only idea of scientific pursuit.

Conclusion. I have now presented a view of the chief points of support which the present state of the social world affords to the renovating influence of the new political philosophy. This introduction may appear long; but it will abridge my future labor by furnishing my readers with a kind of rational programme of the conditions of the subject. Yet more, it indicates clearly what is apt to escape the notice of minds habituated to the superficial and irrational treatment of social questions,—the complete political efficacy of the positive philosophy. The high practical utility of the theory I am about to offer can not be questioned by the haughtiest politician when it has once been demonstrated that the deepest want of modern society is, in its nature, eminently theoretical, and that, consequently, an intellectual, and then a moral reorganization must precede and direct the political.—This mutual relation being established, with a care proportionate to its importance, we must now return,—not again to quit it,—to the strictly scientific point of view of this work, and pursue the study of the phenomena of social physics in a disposition of mind as purely speculative as that in which we surveyed the other fundamental sciences, with no other intellectual ambition than to discover the natural laws of a final order of phenomena, remarkable in the extreme, and never before examined in this way.

Before proceeding, however, to this direct examination, I propose to consider, briefly, the principal philosophical attempts to constitute social science; as a general estimate of this kind will tend to illustrate the nature and spirit of this last great department of positive philosophy.

CHAPTER II.

PRINCIPAL PHILOSOPHICAL ATTEMPTS TO CONSTITUTE A SOCIAL SYSTEM.

History of Social Science.

We have seen that the complex and special nature of social phenomena is the chief reason why the study has remained imperfect to the last; it being impossible to analyze them till the simpler departments of science were understood, and till the great discovery of cerebral physiology had opened a rational access to their examination. To this main consideration we must now add another, which explains more specially why it has never till now been possible to establish social science on a positive basis. This consideration is, that we have not till now been in possession of a range of facts wide enough to disclose the natural laws of social phenomena.

The first rise of speculative doctrine has always, in all sciences, taken place from the theological method, as I have shown. In the case of the anterior sciences, this did not preclude the formation of a positive theory, when once there had been a sufficient perpetuity of phenomena. The materials were ready before there were observers qualified to make a scientific use of them. But, even if observers had been ready, the phenomena of social life were not ample and various enough in early days to admit of their philosophical analysis. Many and profound modifications of the primitive civilization were necessary to afford a sufficient basis for experiment. We shall see hereafter how indispensable was the operation of the theological philosophy in directing the earliest progress of the human mind and of society. Our present business is to notice the obstacles which it presented to the formation of a true social science. It was not, in fact, till modern political revolutions, and especially the French, had proved the insufficiency of the old political system for the social needs of the age that the great idea of Progress could acquire sufficient firmness, distinctness and generality, to serve a scientific purpose. The direction of the social movement was not determined; and social speculation was embarrassed by fanciful notions of oscillating or circular movements, such as even now cause hesitation in able but ill-prepared minds as to the real nature of human progression. Till it is known in what this progression consists, the fact itself may be disputed: since, from such a point of view, humanity may appear to be doomed to an arbitrary succession of identical phases, without ever experiencing a new transformation, gradually directed toward an end determined by the whole constitution of human nature.

Thus all idea of social progress was interdicted to the philosophers of antiquity, for want of materials of political observation. The most eminent and sagacious of them were subject to the common tendency to suppose the contemporary state of things inferior to that of former times. This supposition was the more natural and legitimate because the philosophical works which contained this view coincided, as to date, with the decline of the Greek and Roman *régime*. This decline, which, in relation to the whole of human history, was in fact progress, could not appear so to the ancients, who did not anticipate what was to come. I have before intimated that the first dawning sense of human progression was inspired by Christianity, which, by proclaiming the superiority of the law of Jesus to that of Moses, gave form to the idea of a more perfect state replacing a less perfect, which had been necessary as a preparation. Though Catholicism[*] was, in this, simply the organ of expression of human reason, the service it thus rendered entitles it not the less, as all true philosophers will agree, to our eternal gratitude. But, apart from the mischief of the mysticism and vague obscurity which belong to all applications of the theological method, such a beginning could not possibly suggest any scientific view of social progression: for any such progression was barred at once by the claim of Christianity to be the ultimate stage at which the human mind must stop. The social efficacy of the theological philosophy is now exhausted, and it has become therefore retrograde, as we have seen; but the condition of continuity is an indispensable element in the conception of progress; an idea which would have no power to guide social speculation if it represented progress as limited by its nature to a determinate condition, attained long ago.

It is thus evident that the conception of progress belongs exclusively to the positive philosophy. This philosophy alone can indicate the final term which human nature will be for ever approaching and never attaining; and it alone can prescribe the general course of this gradual development. Accordingly, the only rational ideas of continuous advance are of modern origin, and relate especially to the expansion of the positive sciences which gave birth to them. It may even be worth observing that the first satisfactory view of general progression was proposed by a philosopher whose genius was essentially mathematical; and therefore conversant with the simplest form of the scientific spirit. Whatever may be the value of this observation, it is certain that Pascal was animated by a sense of the progress of the sciences when he uttered the immortal aphorism: "The entire succession of men, through the whole course of ages, must be regarded as one man, always living and incessantly learning." Whatever may have been the actual effect of this first ray of light, it must be admitted that the idea of continuous progress had no scientific consistency, or public regard, till after the memorable controversy, at the beginning of the last century, about a general comparison of the ancients and moderns. In my view, that solemn discussion constitutes a ripe event in the history of the human mind, which thus, for the first time, declared that it had made an irreversible advance. It is needless to point out that the leaders of this great philosophical movement derived all the force of their arguments from the scientific spirit: but it is remarkable that their most illustrious adversaries committed the inconsistency of declaring that they preferred the philosophy of Descartes to that which preceded it.—From this scientific origin the conception spread more and more in a political direction, till, at length, the French revolution manifested the tendency of humanity toward a political system, indeterminate enough, but radically different from the old system. This was the negative view of social progress; ineffectual in itself, but necessary as a preparation for the advent of the positive philosophy, when it should have made its induction from social phenomena, and ascertained their laws.

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[*] This great idea belongs essentially to Catholicism, from which Protestantism derived it in an imperfect, and corrupt manner,—not only by recurring irrationally to the period of the primitive Church, but also by offering for popular guidance the most barbarous and dangerous part of the Scriptures—that which relates to Hebrew antiquity. Mohammedanism pursued the same practice, and thus instituted a mere imitation of Judaic barbarism, without introducing any real amelioration.

Having thus seen how impossible was the formation of social science in ancient times, we are in a condition to appreciate the attempts which were here and there prematurely made. The foregoing analysis shows that the political conditions of the subject are, generally, precisely coincident with the scientific, so as to retard by their competition the possibility of establishing social science on a positive basis. This obstacle has existed even up to our own generation, who can only make a mere beginning in seeking in the past a basis for social science, in virtue of their experience of a revolutionary period, and of their opening perception of the positive principle, as they see it established in the other departments of human knowledge, including that of intellectual and moral phenomena. It would be waste of time, and a departure from my object, to analyze fully the attempts of ancient philosophers to form a political science which was thus clearly impracticable in their day; and I shall therefore merely point out the essential vice of each speculation, thereby justifying the judgment that we have just passed by anticipation, and disclosing the true nature of an enterprise which remains to be begun.

Aristotle's "Politics."

The name of Aristotle first presents itself, his memorable "Politics" being one of the finest productions of antiquity, and furnishing the general type of most of the works on that subject that have followed. This treatise could not possibly disclose any sense of the progressive tendencies of humanity, nor the slightest glimpse of the natural laws of civilization; and it was necessarily occupied by metaphysical discussions of the principle and form of government: but it is truly marvellous that any mind should have produced a work so advanced, and even nearer to a positive view than his other works, at a time when political observation was restricted to a uniform and preliminary social state, and when the nascent positive spirit lived feebly in geometry alone. The analysis by which he refuted the dangerous fancies of Plato and his imitators about community of property evidences a rectitude, a sagacity, and a strength, which, in their application to such subjects, have been rarely equalled, and never surpassed. Thus much I have said, in the way of homage to the first manifestation of human genius on the great subject of government, notwithstanding the evident influence that it has exercised upon philosophical meditation, from its own day to this.

Montesquieu.

The works which succeeded need not detain us. They were merely an accumulation of fresh materials, classified by the type that Aristotle had furnished. The next period worth notice is that in which the preponderance of the positive spirit in the study of phenomena caused the first clear comprehension of the meaning of general laws, and in which the idea of human progress began to assume some consistency; and, to find these two conditions in concurrence, we can hardly go further back than the middle of the last century. The first and most important series of works which then presents itself is that of Montesquieu, first, in his treatise on the "Greatness and Decline of the Romans," and afterward in his "Spirit of Laws." The great strength of this memorable work appears to me to lie in its tendency to regard political phenomena as subject to invariable laws, like all other phenomena. This is manifested at the very outset, in the preliminary chapter, in which, for the first time in the history of the human mind, the general idea of *law* is directly defined, in relation to all, even to political subjects, in the same sense in which it is applied in the simplest positive investigations. The progress of science which had been effected by the labors of Descartes, Galileo, and Kepler, a century before, had rendered the most advanced minds familiar with an incomplete notion of progress. Montesquieu's conception was a generalization of this incomplete notion: and, instead of denying originality to so eminent a service, we may well be amazed that such a conception should be offered, before the positive method had extended beyond the simplest natural phenomena,—being scarcely admitted into the department of chemistry, and not yet heard of in the study of living bodies. And, in the other view, a man must have been in advance of his time, who could conceive of natural laws as the basis of social speculation and action, while all other able men were talking about the absolute and indefinite power of legislators, when armed with due authority, to modify at will the social state. The very qualities, however, which give its pre-eminence to Montesquieu's work prove to us the impossibility of success in an enterprise so premature in regard to its proposed object, the very conditions of which were still impracticable. The project of the work is not fulfilled in its course; and, admirable as are some of its details, it falls back, like all others, upon the primitive type offered by Aristotle's treatise. We find no reference of social phenomena to the laws whose existence was announced at the outset; nor any scientific selection and connection of facts. The general nature of his practical conclusions seems to show how far the execution of his work was from corresponding with his original intention; for his desultory review of the whole mass of social subjects ends in his setting up, as a universal political type, the English parliamentary system, the insufficiency of which, for the satisfaction of modern social requirements, was not, it is true, so conspicuous in his day as it is now, but still discernible enough, as we shall have occasion to see. It was honorable to Montesquieu's philosophical character, that he steered wide of the metaphysical Utopias which lay in his way, and resorted rather to the narrow anchorage at which he rested; but such a resort, so narrow and so barren, proves that he had wandered away from the course announced by himself. The only part of the book which bears any true marks of sustained positivity is that in which the social influence of permanent local causes—of that which, in political language, we may call climate—is considered. This view, evidently derived from Hippocrates, manifests a tendency to attach observed phenomena to forces able to produce them, as in natural philosophy; but the aim has failed. The true political influence of climate is misconceived, and usually much exaggerated, through the common error of analyzing a mere modification before the main action is fully understood; which is much like trying to determine planetary perturbations before ascertaining the chief gravitations. This error was inevitable under Montesquieu's necessary ignorance of the great social laws, while he was bent upon introducing the positive spirit into the domain of politics. He naturally betook himself to the only class of social speculations which seemed fit for his purpose. Pardonable or unavoidable as was his failure, it is a new evidence of the vast gap which lies open at the outset of the science. Montesquieu did not even perceive, any more than others, the fact which should regulate the whole political theory of climate; —that local physical causes, very powerful in the early days of civilization, lose their force in proportion as human development admits of their being neutralized: a view which would certainly have occurred to Montesquieu if he had possessed himself of the fundamental notion of human progression before he treated of the political theory of climate. Thus, this great philosopher proposed a grand enterprise which was premature in two senses, and in which he could not but fail,—first, by bringing social phenomena under the operation of the positive spirit before it had been introduced into the system of biological science; and again, in proposing social reorganization during a period marked out for revolutionary action. This explains why a mind so eminent should have exercised, through its very advancement, an immediate influence very inferior to that of a mere sophist, like Rousseau, whose intellectual state, much better adapted to the disposition of his contemporaries, allowed him to constitute himself, with so remarkable a success, the natural organ of the revolutionary movement of the time. It is by our posterity that Montesquieu will be duly estimated, when the extension of the positive philosophy to social speculations will disclose the high value of the precocious attempts which, though doomed to failure, yield the light by which the general question must be laid down.

Condorcet.

After Montesquieu, the next great addition to Sociology (which is the term I may be allowed to invent to designate Social Physics) was made by Condorcet, proceeding on the views suggested by his illustrious friend Turgot. Turgot's suggestions with regard to the theory of the perfectability of human nature were doubtless the basis of Condorcet's speculation exhibited in his Historical Sketch of the Progress of the Human Mind, in which the scientific conception of the social progression of the race was, for the first time, clearly and directly proposed, with a distinct assertion of its primary importance. The strength of the work lies in its introduction, in which Condorcet exhibits his general idea, and proposes his philosophical project of studying the radical connection of the various social states of mankind. These few immortal pages leave really nothing to be desired in regard to the position of the sociological question at large, which will, in my opinion, rest, through all future time, on this admirable statement. The execution is far from corresponding with the greatness of the project; but no failure in the carrying out can impair the value of the design. The success and the failure may both be easily accounted for by a consideration of the scientific and political knowledge of the time. The expansion of the natural sciences, and especially of chemistry, during the second half of the last century, had thoroughly established in the best minds of the period the idea of positive laws; and the study of living bodies, in the departments of anatomy and taxonomy, if not of physiology, began to assume a truly scientific character. Condorcet's mind was rationally prepared by mathematical study, under the direction of D'Alembert: by his philosophical position in society, he had all the advantage of the expansion of physico-chemical science then taking place; and of the labors of Haller, Jussieu, Linnæus, Buffon, and Vicq-d'Azir in the principal departments of biological knowledge; and it was natural that he should conceive the enterprise of carrying into the speculative study of social phenomena the same positive method which, from the time of Descartes, had been regenerating the entire system of human knowledge. With equal advantages, and his higher order of genius, Montesquieu would, no doubt, have achieved higher results than he has left us. Still, even Condorcet's project was premature, though less so than that of Montesquieu; for a great deficiency remained in the imperfect state of biological knowledge, and especially in the exclusion of intellectual and moral phenomena from treatment by the positive method: and the unfortunate Condorcet did not live to see them assume their proper place. In their absence, he lost himself in wanderings after an indefinite perfectibility, and chimerical and absurd anticipations. Such aberrations, affecting such men, are a lesson to us as to the impossibility of unaided reason overleaping the intervals which have not been steadily explored in the gradual advance of the human mind. As to the political circumstances of the time—the idea of social progression was certainly more distinct and more firm in Condorcet's than in Montesquieu's time: for the tendency of Society to relinquish the ancient social system was becoming evident, though the new system which was to succeed it was but vaguely suspected, even where it was not wholly misconceived. The evil influence of the revolutionary doctrine is singularly exhibited in Condorcet's work, in the form of an inconsistency which must strike every reader. The human race is there represented as having attained a vast degree of perfection at the close of the eighteenth century, while the author attributes an entirely retrogressive influence to almost every doctrine, institution, and preponderant power throughout the whole past. Whereas, the total progress accomplished can be nothing else than the result of the various kinds of partial progress realized since the beginning of civilization, in virtue of the gradual onward course of human nature. Such a state of things as Condorcet describes would be nothing else than a perpetual miracle; and it is not to him, therefore, that we can look for any disclosure of the laws of human development, any appreciation of the transitory nature of the revolutionary philosophy, or any general conception of the future of society. Here again we recognise the philosophical superiority of Montesquieu, who, not having Condorcet's opportunities of estimating the revolutionary spirit, had been able to free his mind from those critical prejudices in regard to the past which formed the views of all around him, and had injured his own earlier speculations. This brief survey of the labors of these great men shows us that the basis of true social science can be fixed only after the revolutionary spirit has begun to decline; and thus the political, as well as the scientific indications of the subject point to our own time as that in which such a science is to be founded. Condorcet gave us a clear exposition of the nature of the enterprise; but the whole accomplishment yet remains to be achieved.

These two attempts are really all that have been made in the right road to social science; for they are the only speculations which have been based on the aggregate of historical facts. I shall have occasion, further on, to notice some attempts which are not worthy to rank with these, and which merely testify to the existing need of social science by showing how various are the directions in which it is sought. On one subject, however, I shall here make a few observations, in order to illustrate further the aim and spirit of my own efforts to constitute a basis for social science. That subject is the nature and object of what is called Political Economy.

Political economy.

We can not impute to political economists any design to establish social science; for it is the express assertion of the most classical among them that their subject is wholly distinct from, and independent of general political science. Yet, sincere as they doubtless are in their dogma of isolation, they are no less sincerely persuaded that they have applied the positive spirit to economical science; and they perpetually set forth their method as the type by which all social theories will be finally regenerated. As this pretension has obtained credit enough to procure the establishment of several professorships for this species of instruction, I find myself obliged to explain why it is that I can not, as would be very desirable, propose to carry on my enterprise from the point reached by these philosophers, but must begin from the beginning. My criticism on political economy in this place is merely for the purpose of showing that it is not the philosophical creation that we want; and I must refer to my exposition as a whole any objectors to my summary estimate of political economy.

It is unfavorable to the philosophical pretensions of the economists that, being almost invariably lawyers or literary men, they have had no opportunity of discipline in that spirit of positive rationality which they suppose they have introduced into their researches. Precluded by their education from any idea of scientific observation of even the smallest phenomena, from any notion of natural laws, from all perception of what demonstration is, they must obviously be incapable of applying, impromptu, a method in which they have had no practice to the most difficult of all analyses. The only philosophical preparation that they can show is a set of vague precepts of general logic, susceptible of no real use; and thus, their conceptions present a purely metaphysical character. There is one great exceptional case which I must at once exempt from this criticism—that of the illustrious philosopher, Adam Smith, who made no pretension to found a new special science, but merely proposed (what he admirably achieved) to illustrate some leading points of social philosophy by luminous analyses relating to the division of employments, the function of money, the general action of banks, etc., and other chief portions of the industrial developments of the human race. Though involved, like all his contemporaries, in the metaphysical philosophy, a mind of such quality as his could not, however distinguished in the metaphysical school, be blinded by its illusions, because his preparatory studies had impressed him with a sense of what constitutes a true scientific method, as is clearly proved by the valuable sketches of the philosophical history of the sciences, and of astronomy in particular, which are published among his posthumous works. The economists have no right to claim Adam Smith as their authority while the whole dogmatic part of their science presents a merely metaphysical character, dressed up with special forms and a list of scientific terms, taken bodily from former philosophical expositions,—as, for instance, from the theologico-metaphysical writings of Spinoza. The contemporary history of this so-called science confirms this judgment of its nature. The most certain signs of conceptions being scientific are continuousness and fertility: and when existing works, instead of being the result and development of those that have gone before, have a character as personal as that of their authors, and bring the most fundamental ideas into question; and when, again, the dogmatic constitution provides for no real and sustained progress, but only for a barren reproduction of old controversies, it is clear that we are dealing with no positive doctrine whatever, but merely with theological or metaphysical dissertations. And this is the spectacle which political economy has presented for half a century past. If our economists were really the scientific successors of Adam Smith, they would show us where they had carried on and completed their master's doctrine, and what new discoveries they had added to his primitive surveys; but looking with an impartial eye upon their disputes on the most elementary ideas of value, utility, production, etc., we might imagine ourselves present at the strangest conferences of the scholiasts of the Middle Ages about the attributes of their metaphysical entities; which indeed economical conceptions resemble more and more, in proportion as they are dogmatized and refined upon. The result in both cases is, but too often, the perversion of the valuable indications of popular good sense, which become confused, inapplicable, and productive only of idle disputes about words. All intelligent men, for instance, understand what is meant by the terms *product* and *producer;* but, from the time that economical metaphysics undertook to define them, the idea of production has become through vicious generalizations, so indeterminate, that conscientious and clear writers are obliged to use circuitous explanations to avoid the use of terms which have become obscure and equivocal. Such abuse is analogous to that which metaphysics has introduced into the study of the human understanding, with regard, for instance, to the general ideas of analysis and synthesis and the like. The avowal of the economists that their science is isolated from that of social philosophy in general, is itself a sufficient confirmation of my judgment; for it is a universal fact in social, as in biological science, that all the various general aspects of the subject are scientifically one, and rationally inseparable, so that they can not be illustrated but by each other. Thus, the economical or industrial analysis of society can not be effected in the positive method, apart from its intellectual, moral, and political analysis, past and present.

And thus does the boasted isolation of political economy testify to its being grounded on a metaphysical basis.

This is the dogmatic aspect of the science. But it would be unjust to forget that, looking at this doctrine historically, and more with a political than a scientific view, it constitutes a final essential part of the system of critical philosophy, which has exercised an indispensable, though transitory influence during the revolutionary period. Political Economy has borne an honorable share in this vast intellectual conflict, by thoroughly discrediting the industrial polity of the Middle Ages, which became more and more injurious, in its descent to our time, to the industry which it had once protected. Such is the credit due to Political Economy. Its worst practical fault is that, like the other portions of the metaphysical philosophy, it systemizes anarchy; and the danger is only aggravated by its use of modern scientific forms. It has not been satisfied with criticising, in much too absolute a way, the industrial polity of the old European sovereignties, without which the industrial development of modern times could never have taken place: it goes far beyond this; it sets up as a universal dogma the absence of all regulating intervention whatever as the best means of promoting the spontaneous rise of society; so that, on every serious occasion, this doctrine can respond to urgent practical needs only by the uniform reproduction of this systematic negation. Because it perceives a natural tendency in society to arrange itself in a certain order, not seeing in this a suggestion of an order to be promoted by social arrangements, it preaches an absence of regulation which, if carried out to the limit of the principle, would lead to the methodical abolition of all government. But here we meet the compensating virtue that political economy insists on all human interests being bound up together, and therefore susceptible of a permanent reconciliation. Though this may be simply the expression of the convictions of popular good sense, philosophy owes a tribute of eternal gratitude to the economists for their excellent service in extinguishing the disastrous and immoral prejudice which concluded the amelioration of the condition of some to be obtained by the deterioration of the condition of somebody else; and that the total amount of wealth was always the same; which is as much as denying industrial development altogether. Notwithstanding this great service, political economy has dangerous tendencies through its opposition to the institution of all industrial discipline. As each serious difficulty arises, in the course of industrial development, political economy ignores it. In the great question of Machinery this is remarkably illustrated. This is one of the cases of inconvenience inherent in every industrial improvement, from its tendency to disturb, more or less, and for a longer or shorter time, the mode of life of the laboring classes. Instead of recognising in the urgent remonstrances called forth by this chasm in our social order one of the most eminent and pressing occasions for the application of social science, our economists can do nothing better than repeat, with pitiless pedantry, their barren aphorism of absolute industrial liberty. Without considering that all human questions, practically regarded, are reducible to mere questions of time, they venture to reply to all complaints that, in the long-run, all classes, and especially the one most injured on the existing occasion, will enjoy a real and permanent amelioration; a reply which will be regarded as derisive, as long as man's life is incapable of being indefinitely lengthened. Such a doctrine publishes its own weakness by showing its want of relation to the aggregate of our practical needs. Would the copyists who were thrown out of employment by the invention of printing have been completely consoled by being convinced that, in the next generation, there would be an equal number of persons living by printing, and many more in succeeding centuries? Yet such is the consolation habitually offered by political economy; and if there were no other evidence, this inefficiency would prove its unfitness to direct, as it proposes to do, the industrial expansion of modern society. And thus it stands condemned, as to its scientific pretensions, and in spite of some important services, from the political as much as from the scientific point of view.

The temporary predilection of men's minds for political economy is, in truth, a new and strong illustration of the instinctive need which prevails to subject social researches to positive methods; and if that were once done, the interest in political economy would disappear. Various other signs of the times testify to the same disposition, which indeed pervades the whole action of our intelligences. I will refer to only one among the multitude of those signs; but it is one which aids in bringing about the satisfaction of the need. I mean the growing inclination for historical study, and the great improvement in that kind of research within two centuries.

Growth of historical study.

Bossuet was, unquestionably, the first who proposed to survey, from a lofty point of view, the whole of the past of society. We can not adopt his explanations, easily derived from theological resources; but the spirit of universality, so thoroughly appreciated, and, under the circumstances, so wonderfully sustained, will always preserve this admirable composition* as a model, suggesting the true result of historical analysis;—the rational co-ordination of the great series of human events, according to a single design; which must, however, be more genuine and complete than that of Bossuet. There is no doubt that this fine piece of instruction has contributed, during both the past and the present century, to the improvement in the character of the chief historical compositions, especially in France and England, and afterward in Germany. Still, history has more of a literary and descriptive than of a scientific character. It does not yet establish a rational filiation in the series of social events, so as to admit (as in other sciences, and allowing for its greater complexity) of any degree of systematic prevision of their future succession. Perhaps the imputation of rashness cast upon the mere proposal of such a treatment of history is the strongest confirmation we could have of its present unscientific character: for such prevision is everywhere else admitted to be the ultimate scientific test. Another evidence exists in the easy credit daily obtained by misty historical theories which explain nothing, and which testify to the literary and metaphysical bias under which history is studied, by minds unacquainted with the great scientific movement of modern times. Again, another evidence is the dogmatic separation which it is attempted to keep up between history and politics. Still, we must admit the growing taste of our age for historical labors to be a happy symptom of philosophical regeneration, however the inclination may be wasted upon superficial and misleading works, sometimes written with a view to immediate popularity by ministering to the popular taste. One of the most promising incidents of the time is the introduction into the highly metaphysical class of jurists of an historical school which has undertaken to connect, during every period of history, the whole of its legislation with the corresponding state of society.

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* "Discourse on Natural History."

If the preceding chapter disclosed the destination of the great philosophical creation of which I am treating, the present exhibits its necessity, and the opportuneness of the time. Attempts to constitute a science of society would not have been so obstinate, nor pursued in ways so various, if an instinctive need of it had not been deeply felt. At the same time, the general analysis of the chief efforts hitherto made explains their failure, and convinces us that the whole enterprise remains to be even conceived of in a manner which will secure its accomplishment. Nothing now prevents our going on to the fulfilment of this proposed task, by entering, in the next chapter, on the study of the method in Social Physics. We have so ascertained and cleared our ground, by first taking a survey of our condition from a political point of view, and then reviewing the preparation made, that we are at full liberty to follow the speculative development that will prevail throughout the rest of this book, which will close with the co-ordination between the theory and practice of Social Physics.

NOTE The foregoing extract, it is believed, will give a tolerable idea of the bearing of the Positive Philosophy on Social Science, and show that Sociology *is a Science*, connected with, and depending on, every previous one; thus mathematically demonstrating the utter futility of attempting, *henceforth* to construct the Social fabric on any other basis than POSITIVISM.—*Publisher.*

CHAPTER III.

CHARACTERISTICS OF THE POSITIVE METHOD IN ITS APPLICATION TO SOCIAL PHENOMENA.

In every science, conceptions which relate to method are inseparable from those which relate to the doctrine under consideration. The method has to be so varied in its application, and so largely modified by the complexity and special nature of the phenomena, in each case, that any general notions of method would be too indefinite for actual use. If, therefore, we have not separated the method from the doctrine in the simpler departments of science, much less should we think of doing so when treating of the complex phenomena of social life, to say nothing of the great feature of this last case—its want of positivity. In the formation of a new science, the general spirit of it must be seized before its particular parts can be investigated: that is, we must have some notion of the doctrine before examining the method, and then the method can not be estimated in any other way than by its use. Thus, I have not to offer a logical exposition of method in social physics before proceeding to the science itself; but I must follow the same plan here as in the case of the anterior sciences,—ascertaining its general spirit, and what are the collective resources proper to it. Though these subjects may be said to belong to the science itself, we may consider them as belonging to the method, as they are absolutely necessary to direct our understandings in the pursuit of this difficult study.

In the higher order of sciences,—in those which are the simplest and the most advanced,—the philosophical definition of each was almost sufficient to characterize their condition and general resources, to which no doubt could attach. But the case is otherwise with a recent and extremely complex study, the very nature of which has to be settled by laborious discussions, which are happily needless in regard to the preceding sciences. In treating of Biology, we found it necessary to dwell upon preparatory explanations which would have seemed puerile in any of the foregoing departments, because the chief bases of a science about which there were still so many disputes, must be indisputably settled before it could take rank in the positive series. It is evident that the same process is even more needful, and must be more laborious, in the case of the science of social development, which has hitherto had no character of positivity at all, and which some of the ablest minds of our time sentence never to have any. We must not be surprised, then if, after applying here the simplest and most radical ideas of positive philosophy, such as would indeed appear trivial in their formal application to the more advanced sciences, the result should appear to many, even among the enlightened, to constitute too bold an innovation, though the conditions may be no more than the barest equivalent of those which are admitted in every other case.

Infantile state of social science.

If we look with a philosophical eye upon the present state of social science, we can not but recognise in it the combination of all the features of that theologico-metaphysical infancy which all the other sciences have had to pass through. The present condition of political science revives before our eyes the analogy of what astrology was to astronomy, alchemy to chemistry, and the search for the universal panacea to the system of medical studies. We may, for our present purpose, consider the theological and the metaphysical polities together,—the second being only a modification of the first in its relation to social science. Their attributes are the same, consisting, in regard to method, in the preponderance of imagination over observation; and, in regard to doctrine, in the exclusive investigation of absolute ideas; the result of both of which is an inevitable tendency to exercise an arbitrary and indefinite action over phenomena which are not regarded as subject to invariable natural laws. In short, the general spirit of all speculation at that stage is at once ideal in its course, absolute in its conception, and arbitrary in its application; and these are unquestionably the prevailing characteristics of social speculation at present, regarded from any point of view whatever. If we reverse all the three aspects, we shall have precisely the spirit which must actuate the formation of positive sociology, and which must afterward direct its continuous development. The scientific spirit is radically distinguished from the theological and metaphysical by the steady subordination of the imagination to observation; and though the positive philosophy offers the vastest and richest field to human imagination, it restricts it to discovering and perfecting the co-ordination of observed facts, and the means of effecting new researches: and it is this habit of subjecting scientific conceptions to the facts whose connection has to be disclosed, which it is above all things necessary to introduce into social researches; for the observations hitherto made have been vague and ill-circumscribed, so as to afford no adequate foundation for scientific reasoning; and they are usually modified themselves at the pleasure of an imagination stimulated by the most fluctuating passions. From their complexity, and their closer connection with human passions, political speculations must be detained longer than any others in this deplorable philosophical condition, in which they are still involved, while simpler and less stimulating sciences have successively obtained emancipation; but we must remember that all other kinds of scientific conception have gone through the same stage, from which they have issued with the more difficulty and delay exactly in proportion to their complexity and special nature. It is, indeed, only in our own day that the more complex have issued from that condition at all, as we saw to be the case with the intellectual and moral phenomena of individual life, which are still studied in a way almost as anti-scientific as political phenomena themselves. We must not, then, consider that uncertainty and vagueness in observation are proper to political subjects. It is only that the same imperfection which has had its day throughout the whole range of speculation is here more intense and protracted; and the same theory which shows how this must be the case gives us full assurance of a philosophical regeneration in this department of science analogous to that which has taken place in the rest, though by means of severer intellectual difficulty, and the embarrassment which may arise from collision with the predominant passions of men; a liability which can not but stimulate the endeavors of real thinkers.

The relative superseding the absolute.

If we contemplate the positive spirit in its relation to scientific conception, rather than the mode of procedure we shall find that this philosophy is distinguished from the theologico-metaphysical by its tendency to render relative the ideas which were at first absolute. This inevitable passage from the absolute to the relative is one of the most important philosophical results of each of the intellectual revolutions which has carried on every kind of speculation from the theological or metaphysical to the scientific state. In a scientific view, this contrast between the relative and the absolute may be regarded as the most decisive manifestation of the antipathy between the modern philosophy and the ancient. All investigation into the nature of beings, and their first and final causes, must always be absolute; whereas the study of the laws of phenomena must be relative, since it supposes a continuous progress of speculation subject to the gradual improvement of observation, without the precise reality being ever fully disclosed: so that the relative character of scientific conceptions is inseparable from the true idea of natural laws, just as the chimerical inclination for absolute knowledge accompanies every use of theological fictions and metaphysical entities. Now, it is obvious that the absolute spirit characterizes social speculation now, wherever it exists, as the different schools are all agreed in looking for an immutable political type, which makes no allowance for the regular modification of political conceptions according to the variable state of civilization. This absolute spirit, having prevailed through all social changes, and their corresponding philosophical divergences, is now so inherent in existing political science that it affords amid all its enormous evils, the only means of restraining individual eccentricities, and excluding the influx of arbitrarily variable opinions. Thus, such philosophers as have desired to emancipate themselves from this absolutism, without having risen to the conception of a positive social philosophy, have justly incurred the reproach of representing political ideas as uncertain and even arbitrary in their nature, because they have deprived them of whatever character of consistency they had, without substituting any other. They have even cast a sort of discredit upon all philosophical enterprise in the direction of political science, which, losing its absolutism, seemed to lose its stability, and therefore its morality. A positive sociology, however, would put to flight all these natural, though empirical fears; for all antecedent experience shows that in other departments of natural philosophy, scientific ideas have not become arbitrary by becoming relative, but have, on the contrary, acquired a new consistence and stability by being implicated in a system of relations which is ever extending and strengthening, and more and more restraining all serious aberration. There is therefore no fear of falling into a dangerous skepticism by destroying the absolute spirit, if it is done in the natural course of passing on toward the positive state. Here, as elsewhere, it is characteristic of the positive philosophy to destroy no means of intellectual co-ordination without substituting one more effectual and more extended; and it is evident that this transition from the absolute to the relative offers the only existing means of attaining to political conceptions that can gradually secure a unanimous and permanent assent.

The importance and soundness of these conditions are less conspicuous than they might be, on account of the too close connection which, in social science more than any other, still exists between theory and practice, in consequence of which all speculative and abstract appreciation, however supremely important, excites only a feeble interest and inadequate attention. To show how this confusion results from the imperfection of social science, as the most complex of all, we must look at the existing political spirit in relation to its general application, and not for the moment in relation to the science itself. In this view we see that the existing political spirit is marked by its disposition to exercise an illimitable action over the corresponding phenomena, as it was once supposed possible to do in other departments of philosophy. Men were long in learning that Man's power of modifying phenomena can result only from his knowledge of their natural laws; and in the infancy of each science, they believed themselves able to exert an unbounded influence over the phenomena of that science. As this happened precisely at the period when they had the least power over phenomena, from ignorance of their laws, they rested their confidence on expectations of aid from supernatural agents, or mysterious forces supposed to be inherent in all that they saw. The delusion was protracted, and the growth of true science hindered in proportion, by the increasing complexity of the descending sciences, as each order of phenomena exhibited less generality than the last, and obscured the perception as to what the modifying power of Man really is. Social phenomena are, of course, from their extreme complexity, the last to be freed from this pretension: but it is therefore only the more necessary to remember that the pretension existed with regard to all the rest, in their earliest stage, and to anticipate therefore that social science will, in its turn, be eman-

Presumptuous character of the existing political spirit.

cipated from the delusion. It still hangs about the class of intellectual and moral phenomena; but otherwise it is now confined to social subjects. There, amidst the dawning of a sounder philosophy, we see statesmen and politicians still supposing that social phenomena can be modified at will, the human race having, in their view, no spontaneous impulsion, but being always ready to yield to any influence of the legislator, spiritual or temporal, provided he is invested with a sufficient authority. We see the theological polity, as before, more consistent than the metaphysical, explaining the monstrous disproportion between slight causes and vast effects, by regarding the legislator as merely the organ of a supernatural and absolute power: and again, we see the metaphysical school following the same course, merely substituting for Providence its unintelligible entities, and especially its grand entity, Nature, which comprehends all the rest, and is evidently only an abstract deterioriation of the theological principle. Going further than the theological school in its disdain of the subjection of effects to causes, it escapes from difficulty by attributing observed events to chance, and sometimes, when that method is too obviously absurd, exaggerating ridiculously the influence of the individual mind upon the course of human affairs. The result is the same in both cases. It represents the social action of Man to be indefinite and arbitrary, as was once thought in regard to biological, chemical, physical, and even astronomical phenomena, in the earlier stages of their respective sciences. It is easy to see that true political science would be unacceptable, because it must impose limits on political action, by dissipating for ever the pretension of governing at will this class of phenomena, and withdrawing them from human or super-human caprice. In close connection with the tendency to absolute conceptions, we must recognise in this delusion the chief intellectual cause of the social disturbance which now exists; for the human race finds itself delivered over, without logical protection, to the ill-regulated experimentation of the various political schools, each one of which strives to set up, for all future time, its own immutable type of government. We have seen what are the chaotic results of such a strife: and we shall find that there is no chance of order and agreement but in subjecting social phenomena, like all others, to invariable natural laws, which shall, as a whole, prescribe for each period, with entire certainty, the limits and character of political action:—in other words, introducing into the study of social phenomena the same positive spirit which has regenerated every other branch of human speculation. Such a procedure is the true scientific basis of human dignity; as the chief tendencies of man's nature thus acquire a solemn character of authority which must be always respected by rational legislation; whereas the existing belief in the indefinite power of political combinations, which seems at first to exalt the importance of Man, issues in attributing to him a sort of social automatism passively directed by some supremacy of either Providence or the human ruler. I have said enough to show that the central difficulty in the task of regenerating political science is to rectify such an error of conception, at a time, when our prevailing intellectual habits render it difficult to seize social conceptions in any other than their practical aspect, and when their scientific, and yet more, their logical relations are obscured by the prepossessions of the general mind.

Prevision of social phenomena

The last of the preliminary considerations that we have to review is that of the scientific prevision of phenomena, which, as the test of true science, includes all the rest. We have to contemplate social phenomena as susceptible of prevision, like all other classes, within the limits of exactness compatible with their higher complexity. Comprehending the three characteristics of political science which we have been examining, prevision of social phenomena supposes first, that we have abandoned the region of metaphysical idealities, to assume the ground of observed realities by a systematic subordination of imagination to observation; secondly, that political conceptions have ceased to be absolute, and have become relative to the variable state of civilization, so that theories, following the natural course of facts, may admit of our foreseeing them; and, thirdly, that permanent political action is limited by determinate laws, since, if social events were always exposed to disturbance by the accidental intervention of the legislator, human or divine, no scientific prevision of them would be possible. Thus, we may concentrate the conditions of the spirit of positive social philosophy on this one great attribute of scientific prevision. This concentration is all the more apt for the purpose of our inquiry, because there is no other view in which the new social philosophy is so clearly distinguished from the old. Events ordered by a supernatural will may leave room for a supposition of revelation; but the very thought of prevision in that case is sacrilegious; and the case is essentially the same when the direction of events is assigned to metaphysical entities, except that it leaves the chance of revelation; the existence of which chance shows that the metaphysical conception is a mere modification of the theological. The old conceptions may evidently be applied to explain opposite facts equally well; and they can never afford the slightest indication of those which are yet future. And, if it be objected that, at all times, a great number of secondary political facts have been considered susceptible of prevision, this only proves that the old philosophy has never been strictly universal, but has always been tempered by an admixture of feeble and imperfect positivism, without more or less of which society could not have held on its course. This admixture has, however, been hitherto insufficient to allow anything worthy the name of prevision—anything more than a sort of popular forecast of some secondary and partial matters—never rising above an uncertain and rough empiricism, which might be of some provisional use, but could not in any degree supply the need of a true political philosophy.

Having now ascertained the fundamental position of the problems of political philosophy, and thus obtained guidance as to the scientific aim to be attained, the next step is to exhibit the general spirit of Social Physics, whose conditions we have been deciding.

Spirit of Social Science.

The philosophical principle of the science being that social phenomena are subject to natural laws, admitting of rational prevision, we have to ascertain what is the precise subject, and what the peculiar character of those laws. The distinction between the Statical and Dynamical conditions of the subject must be extended to social science; and I shall treat of the conditions of social existence as, in biology, I treated of organization under the head of anatomy; and then of the laws of social movement, as in biology of those of life, under the head of physiology. This division, necessary for exploratory purposes, must not be stretched beyond that use: and, as we saw in Biology, that the distinction becomes weaker with the advance of science, so shall we see that when the science of social physics is fully constituted, this division will remain for analytical purposes, but not as a real separation of the science into two parts. The distinction is not between two classes of facts, but between two aspects of a theory. It corresponds with the double conception of order and progress; for order consists (in a positive sense) in a permanent harmony among the conditions of social existence; and progress consists in social development; and the conditions in the one case, and the laws of movement in the other, constitute the statics and dynamics of social physics. And here we find again the constant relation between the science and the art—the theory and the practice. A science which proposes a positive study of the laws of order and of progress cannot be charged with speculative rashness by practical men of any intelligence, since it offers the only rational basis for the practical means of satisfying the needs of society, as to order and progress; and the correspondence in this case will be found to be analogous to that which we have seen to exist between biological science and the arts which relate to it—the medical art especially. One view of the deepest interest in this connection is that the ideas of order and progress which are in perpetual conflict in existing society, occasioning infinite disturbance, are thus reconciled, and made necessary to each other, becoming as truly inseparable as the ideas of organization and life in the individual being. The further we go in the study of the conditions of human society, the more clearly will the organizing and progressive spirit of the positive philosophy become manifest.

Statical study.

The statical study of sociology consists in the investigation of the laws of action and reaction of the different parts of the social system—apart, for the occasion, from the fundamental movement which is always gradually modifying them. In this view, sociological prevision, founded upon the exact general knowledge of those relations, acts by judging by each other the various statical indications of each mode of social existence, in conformity with direct observation—just as is done daily in the case of anatomy. This view condemns the existing philosophical practice of contemplating social elements separately, as if they had an independent existence; and it leads us to regard them as in mutual relation, and forming a whole which compels us to treat them in combination. By this method, not only are we furnished with the only possible basis for the study of social movement, but we are put in possession of an important aid to direct observation; since many social elements which can not be investigated by immediate observation, may be estimated by their scientific relation to others already known. When we have a scientific knowledge of the interior relation of the parts of any science or art; and again, of the relations of the sciences to each other; and again, of the relations of arts to their respective sciences, the observation of certain portions of the scheme enables us to pronounce on the state of other portions, with a true philosophical security. The case is the same when, instead of studying the collective social phenomena of a single nation, we include in the study those of contemporary nations, whose reciprocal influence can not be disputed, though it is much reduced in modern times, and, as in the instance of western Europe and eastern Asia, apparently almost effaced.

Social Organization.

The only essential case in which this fundamental relation is misconceived or neglected is that which is the most important of all—involving, as it does, social organization, properly so called. The theory of social organization is still conceived of as absolute and isolated, independent altogether of the general analysis of the corresponding civilization, of which it can, in fact, constitute only one of the principal elements. This vice is chargeable in an almost equal degree upon the most opposite political schools, which agree in abstract discussions of political systems, without thinking of the coexisting state of civilization, and usually conclude with making their immutable political type coincide with an infantile state of human development. If we ascend to the philosophical source of this error, we shall find it, I think, in the great theological dogma of the Fall of Man. This fundamental dogma, which reappears, in one form or another, in all religions, and which is supported in its intellectual influence by the natural propensity of men to admire the past, tends, directly and necessarily, to make the continuous deterioration of society coincide with the extension of civilization. We have noticed before how, when it passes from the theological into the metaphysical state, this dogma takes the form of the celebrated hypothesis of a chimerical state of nature, superior to the social state, and the more remote, the farther we advance in civilization. We can not fail to perceive the extreme seriousness, in a political as well as a philosophical sense, of an error so completely incorporated with existing doctrines, and so deeply influencing, in an unconscious way, our collective social speculations—the more disastrously, perhaps, for not being expressly maintained as a general principle. If it were so presented, it must immediately give way before sound philosophical discussion;

for it is in direct contradiction to many ideas in political philosophy which, without having attained any scientific consistency, are obtaining some intellectual ascendency, through the natural course of events, or the expansion of the general mind. For instance, all enlightened political writers acknowledge more or less mutual relation between political institutions; and this is the first direct step toward the rational conception of the agreement of the special system of institutions with the total system of civilization. We now see the best thinkers admitting a constant mutual connection between the political and the civil power: which means, in scientific language, that preponderating social forces always end in assuming the direction of society. Such partial advances toward a right view—such fortunate feeling after the right path, must not, however, induce us to relax in our requirements of a true philosophical conception of that general social agreement which can alone constitute organization. Desultory indications, more literary than scientific, can never supply the place of a strict philosophical doctrine, as we may see from the fact that, from Aristotle downward (and even from an earlier period), the greater number of philosophers have constantly reproduced the famous aphorism of the necessary subordination of laws to manners, without this germ of sound philosophy having had any effect on the general habit of regarding institutions as independent of the coexisting state of civilization—however strange it may seem that such a contradiction should live through twenty centuries. This is, however, the natural course with intellectual principles and philosophical opinions, as well as with social manners and political institutions. When once they have obtained possession of men's minds, they live on, notwithstanding their admitted impotence and inconvenience, giving occasion to more and more serious inconsistencies, till the expansion of human reason originates new principles, of equivalent generality and superior rationality. We must not therefore take for more than their worth the desultory attempts that we see made in the right direction, but must insist on the principle which lies at the heart of every scheme of social organization—the necessary participation of the collective political *régime* in the universal consensus of the social body.

Political and social concurrence.

The scientific principle of the relation between the political and the social condition is simply this;—that there must always be a spontaneous harmony between the whole and the parts of the social system, the elements of which must inevitably be, sooner or later, combined in a mode entirely conformable to their nature. It is evident that not only must political institutions and social manners on the one hand, and manners and ideas on the other, be always mutually connected; but, further, that this consolidated whole must be always connected, by its nature, with the corresponding state of the integral development of humanity, considered in all its aspects, of intellectual, moral, and physical activity: and the only object of any political system whatever, temporal or spiritual, is to regulate the spontaneous expansion so as best to direct it toward its determinate end. Even during revolutionary periods, when the harmony appears furthest from being duly realized, it still exists: for without it there would be a total dissolution of the social organism. During those exceptional seasons, the political *régime* is still, in the long run, in conformity with the corresponding state of civilization, as the disturbances which are manifest in the one proceed from equivalent derangements in the other. It is observable that when the popular theory attributes to the legislator the permanent power of infringing the harmony we are speaking of, it supposes him to be armed with a sufficient authority. But every social power, whether called authority or anything else, is constituted by a corresponding assent, spontaneous or deliberate, explicit or implicit, of various individual wills, resolved from certain preparatory convictions, to concur in a common action, of which this power is first the organ, and then the regulator. Thus, authority is derived from concurrence, and not concurrence from authority (setting aside the necessary reaction): so that no great power can arise otherwise than from the strongly prevalent disposition of the society in which it exists: and when there is no strong preponderance, such powers as exist are weak accordingly: and the more extensive the society, the more irresistible is the correspondence. On the other hand, there is no denying the influence which, by a necessary reaction, the political system, as a whole, exercises over the general system of civilization, and which is so often exhibited in the action, fortunate or disastrous, of institutions, measures, or purely political events, even upon the course of the sciences and arts, in all ages of society, and especially the earliest. We need not dwell on this; for no one denies it. The common error, indeed, is to exaggerate it, so as to place the reaction before the primary action. It is evident, considering their scientific relation to each other, that both concur in creating that fundamental agreement of the social organism which I propose to set forth in a brief manner, as the philosophical principle of statical sociology. We shall have to advert repeatedly to the subject of the general correspondence between the political *régime* and the contemporary state of civilization, in connection with the question of the necessary limits of political action, and in the chapter which I must devote to social statics: but I did not think fit to wait for these explanations before pointing out that the political system ought always to be regarded as relative. The relative point of view, substituted for the absolute tendency of the ordinary theories, certainly constitutes the chief scientific character of the positive philosophy in its political application. If, on the one hand, the conception of this connection between government and civilization presents all ideas of political good or evil as necessarily relative and variable (which is quite another thing than being arbitrary), on the other hand, it provides a rational basis for a positive theory of the spontaneous order of human society, already vaguely perceived, in regard to some minor relations, by that part of the metaphysical polity which we call political economy; for, if the value of any political system can consist in nothing but its harmony with the corresponding social state, it follows that in the natural course of events, and in the absence of intervention, such a harmony must necessarily be established.

Interconnection of the social organism.

There are two principal considerations which induce me to insist on this elementary idea of the radical consensus proper to the social organism: first, the extreme philosophical importance of this master-thought of social statics, which must, from its nature, constitute the rational basis of any new political philosophy; and, secondly, in an accessory way, that dynamical considerations of sociology must prevail throughout the rest of this work, as being at present more interesting, and therefore better understood; and it is, on that account, the more necessary to characterize now the general spirit of social statics, which will henceforth be treated only in an indirect and implicit way. As all artificial and voluntary order is simply a prolongation of the natural and involuntary order to which all human society tends, every rational political institution must rest upon an exact preparatory analysis of corresponding spontaneous tendencies, which alone can furnish a sufficiently solid basis. In brief, it is our business to contemplate order, that we may perfect it; and not to create it; which would be impossible. In a scientific view, this master-thought of universal social interconnection becomes the consequence and complement of a fundamental idea established, in our view of biology, as eminently proper to the study of living bodies. Not that this idea of interconnection is peculiar to that study: it is necessarily common to all phenomena; but amidst immense differences in intensity and variety, and therefore in philosophical importance. It is, in fact, true that wherever there is any system whatever, a certain interconnection must exist. The purely mechanical phenomena of astronomy offer the first suggestion of it; for the perturbations of one planet may sensibly affect another, through a modified gravitation. But the relation becomes closer and more marked in proportion to the complexity and diminished generality of the phenomena, and thus, it is in organic systems that we must look for the fullest mutual connection. Hitherto, it had been merely an accessory idea; but then it becomes the basis of positive conceptions; and it becomes more marked, the more compound are the organisms, and the more complex the phenomena in question, —the animal interconnection being more complete than the vegetable, and the human more than the brute; the nervous system being the chief seat of the biological interconnection. The idea must therefore be scientifically preponderant in social physics, even more than in biology, where it is so decisively recognised by the best order of students. But the existing political philosophy supposes the absence of any such interconnection among the aspects of society; and it is this which has rendered it necessary for me now to establish the point, leaving the illustration of it to a future portion of the volume. Its consideration is, in fact, as indispensable in assigning its encyclopædic rank to social science as we before saw it to be in instituting Social Physics a science at all.

It follows from this attribute that there can be no scientific study of society, either in its conditions or its movements, if it is separated into portions, and its divisions are studied apart. I have already remarked upon this, in regard to what is called political economy. Materials may be furnished by the observation of different departments; and such observation may be necessary for that object; but it can not be called science. The methodical division of studies which takes place in the simple inorganic sciences is thoroughly irrational in the recent and complex science of society, and can produce no results. The day may come when some sort of subdivision may be practicable and desirable; but it is impossible for us now to anticipate what the principle of distribution may be; for the principle itself must arise from the development of the science; and that development can take place no otherwise than by our formation of the science as a whole. The complete body will indicate for itself, at the right season, the particular points which need investigation; and then will be the time for such special study as may be required. By any other method of proceeding, we shall only find ourselves encumbered with special discussions, badly instituted, worse pursued, and accomplishing no other purpose than that of impeding the formation of real science. It is no easy matter to study social phenomena in the only right way,—viewing each element in the light of the whole system. It is no easy matter to exercise such vigilance as that no one of the number of contemporary aspects shall be lost sight of. But it is the right and the only way; and we may perceive in it a clear suggestion that this lofty study should be reserved for the highest order of scientific minds, better prepared than others, by wise educational discipline, for sustained speculative efforts, aided by an habitual subordination of the passions to the reason. There is no need to draw out any lengthened comparison between this state of things as it should be and that which is. And no existing degree of social disturbance can surprise us when we consider how intellectual anarchy is at the bottom of such disturbance, and see how anarchical our intellectual condition appears in the presence of the principle I have laid down.

Order of statical study.

Before we go on to the subject of social dynamics, I will just remark that the prominent interconnection we have been considering prescribes a procedure in organic studies different from that which suits inorganic. The metaphysicians announce as an aphorism that we should always, in every kind of study, proceed from the simple to the compound: whereas, it appears most rational to suppose that we should follow that or the reverse method, as may best suit our subject. There can be no absolute merit in the method enjoined, apart from its suitableness.

The rule should rather be (and there probably was a time when the two rules were one) that we must proceed from the more known to the less. Now, in the inorganic sciences, the elements are much better known to us than to the whole which they constitute: so that in that case we must proceed from the simple to the compound. But the reverse method is necessary in the study of Man and of Society; Man and Society as a whole being better known to us, and more accessible subjects of study, than the parts which constitute them. In exploring the universe, it is as a whole that it is inaccessible to us; whereas, in investigating Man or Society, our difficulty is in penetrating the details. We have seen, in our survey of biology, that the general idea of animal nature is more distinct to our minds than the simpler notion of vegetable nature; and that man is the biological unity; the idea of Man being at once the most compound, and the starting-point of speculation in regard to vital existence. Thus, if we compare the two halves of natural philosophy, we shall find that in the one case it is the last degree of composition, and, in the other, the last degree of simplicity, that is beyond the scope of our research. As for the rest, it may obviate some danger of idle discussions to say that the positive philosophy, subordinating all fancies to reality, excludes logical controversies about the absolute value of this or that method, apart from its scientific application. The only ground of preference being the superior adaptation of any means to the proposed end, this philosophy may, without any inconsistency, change its order of proceeding when the one first tried is found to be inferior to its converse:—a discovery of which there is no fear in regard to the question we have now been examining.

Dynamical study.

Passing on from statical to dynamical sociology, we will contemplate the philosophical conception which should govern our study of the movement of society. Part of this subject is already despatched, from the explanations made in connection with statics having simplified the chief difficulties of the case. And social dynamics will be so prominent throughout the rest of this work, that I may reduce within very small compass what I have to say now under that head.

Though the statical view of society is the basis of sociology, the dynamical view is not only the more interesting of the two, but the more marked in its philosophical character from its being more distinguished from biology by the master-thought of continuous progress, or rather, of the gradual development of humanity. If I were writing a methodical treatise on political philosophy, it would be necessary to offer a preliminary analysis of the individual impulsions which make up the progressive force of the human race, by referring them to that instinct which results from the concurrence of all our natural tendencies, and which urges man to develop the whole of his life, physical, moral, and intellectual, as far as his circumstances allow. But this view is admitted by all enlightened philosophers; so that I may proceed at once to consider the continuous succession of human development, regarded in the whole race, as if humanity were one. For clearness, we may take advantage of Condorcet's device of supposing a single nation to which we may refer all the consecutive social modifications actually witnessed among distinct peoples. This rational fiction is nearer the reality than we are accustomed to suppose; for, in a political view, the true successors of such or such a people are certainly those who, taking up and carrying out their primitive endeavors, have prolonged their social progress, whatever may be the soil which they inhabit, or even the race from which they spring. In brief, it is political continuity which regulates sociological succession, though the having a common country must usually affect this continuity in a high degree. As a scientific artifice merely, however, I shall employ this hypothesis, and on the ground of its manifest utility.

Social continuity.

The true general spirit of social dynamics then consists in conceiving of each of these consecutive social states as the necessary result of the preceding, and the indispensable mover of the following, according to the axiom of Leibnitz—*the present is big with the future*. In this view, the object of science is to discover the laws which govern this continuity, and the aggregate of which determines the course of human development. In short, social dynamics studies the laws of succession, while social statics inquires into those of co-existence; so that the use of the first is to furnish the true theory of progress to political practice, while the second performs the same service in regard to order; and this suitability to the needs of modern society is a strong confirmation of the philosophical character of such a combination.

Produce by natural laws.

If the existence of sociological laws has been established in the more difficult and uncertain case of the statical condition, we may assume that they will not be questioned in the dynamical province. In all times and places, the ordinary course of even our brief individual life has disclosed certain remarkable modifications which have occurred, in various ways, in the social state; and all the most ancient representations of human life bear unconscious and most interesting testimony to this, apart from all systematic estimate of the fact. Now it is the slow, continuous accumulation of these successive changes which gradually constitutes the social movement, whose steps are ordinarily marked by generations, as the most appreciable elementary variations are wrought by the constant renewal of adults. At a time when the average rapidity of this progression seems to all eyes to be remarkably accelerated, the reality of the movement can not be disputed, even by those who most abhor it. The only question is about the constant subjection of these great dynamical phenomena to invariable natural laws, a proposition about which there is no question to any one who takes his stand on positive philosophy. It is easy however to establish, from any point of view, that the successive modifications of society have always taken place in a determinate order, the rational explanation of which is already possible in so many cases that we may confidently hope to recognise it ultimately in all the rest. So remarkable is the steadiness of this order, moreover, that it exhibits an exact parallelism of development among distinct and independent populations, as we shall see when we come to the historical portion of this volume. Since, then, the existence of the social movement is unquestionable, on the one hand, and, on the other, the succession of social states is never arbitrary, we can not but regard this continuous phenomenon as subject to natural laws as positive as those which govern all other phenomena, though more complex. There is in fact no intellectual alternative; and thus it is evident that it is on the ground of social science that the great conflict must soon terminate which has gone on for three centuries between the positive and the theologico-metaphysical spirit. Banished for ever from all other classes of speculation, in principle at least, the old philosophies now prevail in social science alone; and it is from this domain that they have to be excluded, by the conception of the social movement being subject to invariable natural laws, instead of to any will whatever.

Though the fundamental laws of social interconnection are especially verified in this condition of movement, and though there is a necessary unity in this phenomenon, it may be usefully applied, for preparatory purposes, to the separate elementary aspects of human existence, physical, moral, intellectual, and, finally, political,—their mutual relation being kept in view. Now, in whichever of these ways we regard, as a whole, the movement of humanity, from the earliest periods till now, we shall find that the various steps are connected in a determinate order; as we shall hereafter see, when we investigate the laws of this succession. I need refer here only to the intellectual evolution, which is the most distinct and unquestionable of all, as it has been the least impeded and most advanced of any, and has therefore been usually taken for guidance. The chief part of this evolution, and that which has most influenced the general progression, is no doubt the development of the scientific spirit, from the primitive labors of such philosophers as Thales and Pythagoras to those of men like Lagrange and Bichat. Now, no enlightened man can doubt that, in this long succession of efforts and discoveries, the human mind has pursued a determinate course, the exact preparatory knowledge of which might have allowed a cultivated reason to foresee the progress proper to each period. Though the historical considerations cited in previous pages were only incidental, any one may recognise in them numerous and indisputable examples of this necessary succession, more complex perhaps, but not more arbitrary than any natural law, whether in regard to the development of each separate science, or to the mutual influence of the different branches of natural philosophy. In accordance with the principles laid down at the beginning of this work, we have already seen, in various signal instances, that the chief progress of each period, and even of each generation, was a necessary result of the immediately preceding state; so that the men of genius, to whom such progression has been too exclusively attributed, are essentially only the proper organs of a predetermined movement, which would, in their absence, have found other issues. We find a verification of this in history, which shows that various eminent men were ready to make the same great discovery at the same time, while the discovery required only one organ. All the parts of the human evolution admit of analogous observations, as we shall presently see, though they are more complex and less obvious than that which I have just cited. The natural progression of the arts of life is abundantly evident; and in our direct study of social dynamics we shall find an explanation of the apparent exception of the fine arts, which will be found to oppose no contradiction to the general course of human progression. As to that part of the movement which appears at present to be at least reducible to natural laws, the political movement (still supposed to be governed by wills of adequate power), it is as clear as in any other case that political systems have exhibited an historical succession, according to a traceable filiation, in a determinate order, which I am prepared to show to be even more inevitable than that of the different states of human intelligence.

The interconnection which we have examined and established in a statical view may aid us in developing the conception of the existence of positive laws in social dynamics. Unless the movement was determined by those laws, it would occasion the entire destruction of the social system. Now, that interconnection simplifies and strengthens the preparatory indications of dynamic order; for, when it has once been shown in any relation, we are authorized to extend it to all others; and this unites all the partial proofs that we can successively obtain of the reality of this scientific conception. In the choice and the application of these verifications, we must remember that the laws of social dynamics are most recognisable when they relate to the largest societies, in which secondary disturbances have the smallest effect. Again, these fundamental laws become the more irresistible, and therefore the more appreciable, in proportion to the advancement of the civilization upon which they operate, because the social movement becomes more distinct and certain with every conquest over accidental influences. As for the philosophical co-ordination of these preparatory evidences, the combination of which is important to science, it is clear that the social evolution must be more inevitably subject to natural laws, the more compound are the phenomena, and the less perceptible, therefore, the irregularities which arise from individual influences. This shows how inconsistent it is, for instance, to suppose the scientific movement to be subject to positive laws, while the political movement is regarded as arbitrary; for the latter, being more composite, must overrule individual disturbances, and be therefore more evidently predetermined than the former, in which individual genius must have more power. Any paradoxical appearance which this statement may exhibit will disappear in the course of further examination.

If I confined myself strictly to a scientific view, I might satisfy myself with proving the fact of social progression, without taking any notice of the question of human perfectibility. But so much time and effort are wasted in groundless speculation on that interesting question, argued as it is on the supposition that political events are arbitrarily determined, that it may be as well to notice it in passing; and the more, because it may serve as a natural transition to the estimate of the limits of political action.

Notion of Human perfectibility.

We have nothing to do here with the metaphysical controversy about the absolute happiness of Man at different stages of civilization. As the happiness of every man depends on the harmony between the development of his various faculties and the entire system of the circumstances which govern his life; and as, on the other hand, this equilibrium always establishes itself spontaneously to a certain extent, it is impossible to compare in a positive way, either by sentiment or reasoning, the individual welfare which belongs to social situations that can never be brought into direct comparison: and therefore the question of the happiness of different animal organisms, or of their two sexes, is merely impracticable and unintelligible. The only question, therefore, is of the effect of the social evolution, which is so undeniable that there is no reasoning with any one who does not admit it as the basis of the inquiry. The only ground of discussion is whether development and improvement,—the theoretical and the practical aspect,—are one; whether the development is necessarily accompanied by a corresponding amelioration, or progress, properly so called. To me it appears that the amelioration is as unquestionable as the development from which it proceeds, provided we regard it as subject, like the development itself, to limits, general and special, which science will be found to prescribe. The chimerical notion of unlimited perfectibility is thus at once excluded. Taking the human race as a whole, and not any one people, it appears that human development brings after it, in two ways, an ever-growing amelioration, first, in the radical condition of Man, which no one disputes; and next, in his corresponding faculties, which is a view much less attended to. There is no need to dwell upon the improvement in the conditions of human existence, both by the increasing action of Man on his environment through the advancement of the sciences and arts, and by the constant amelioration of his customs and manners; and again, by the gradual improvement in social organization. We shall presently see that in the Middle Ages, which are charged with political retrogression, the progress was more political than any other. One fact is enough to silence sophistical declamation on this subject; the continuous increase of population all over the globe, as a consequence of civilization, while the wants of individuals are, as a whole, better satisfied at the same time. The tendency to improvement must be highly spontaneous and irresistible to have persevered notwithstanding the enormous faults—political faults especially—which have at all times absorbed or neutralized the greater part of our social forces. Even throughout the revolutionary period, in spite of the marked discordance between the political system and the general state of civilization, the improvement has proceeded, not only in physical and intellectual, but also in moral respects, though the transient disorganization could not but disturb the natural evolution. As for the other aspect of the question, the gradual and slow improvement of human nature, within narrow limits, it seems to me impossible to reject altogether the principle proposed (with great exaggeration, however) by Lamarck, of the necessary influence of a homogeneous and continuous exercise in producing, in every animal organism, and especially in Man, an organic improvement, susceptible of being established in the race, after a sufficient persistence. If we take the best-marked case—that of intellectual development, it seems to be unquestionable that there is a superior aptitude for mental combinations, independent of all culture, among highly-civilized people; or, what comes to the same thing, an inferior aptitude among nations that are less advanced,—the average intellect of the members of those societies being taken for observation. The intellectual faculties are, it is true, more modified than the others by the social evolution: but then they have the smallest relative effect in the individual human constitution: so that we are authorized to infer from their amelioration a proportionate improvement in aptitudes that are more marked and equally exercised. In regard to morals, particularly, I think it indisputable that the gradual development of humanity favors a growing preponderance of the noblest tendencies of our nature,—as I hope to prove further on. The lower instincts continue to manifest themselves in modified action, but their less sustained and more repressed exercise must tend to debilitate them by degrees; and their increasing regulation certainly brings them into involuntary concurrence in the maintenance of a good social economy; and especially in the case of the least marked organisms, which constitute a vast majority. These two aspects of social evolution, then,—the *development* which brings after it the *improvement*,—we may consider to be admitted as facts.

Adhering to our relative, in opposition to the absolute view, we must conclude the social state, regarded as a whole, to have been as perfect, in each period, as the co-existing condition of humanity and of its environment would allow. Without this view, history would be incomprehensible; and the relative view is as indispensable in regard to progress, as, in considering social statics, we saw it to be in regard to order. If, in a statical view, the various social elements can not but maintain a spontaneous harmony, which is the first principle of order; neither can any of them help being as advanced, at any period, as the whole system of influences permits. In either case, the harmony and the movement are the result of invariable natural laws which produce all phenomena whatever and are more obscure in social science merely on account of the greater complexity of the phenomena concerned.

Limits of political action.

And now occurs, as the last aspect of social dynamics, the question of the general limits of political action. No enlightened man can be blind to the necessary existence of such limits, which can be ignored only on the old theological supposition of the legislator being merely the organ of a direct and continuous Providence, which admits of no limits. We need not stop to confute that hypothesis, which has no existence but in virtue of ancient habits of thought. In any case, human action is very limited, in spite of all aids from concurrence and ingenious methods; and it is difficult to perceive why social action should be exempt from this restriction, which is an inevitable consequence of the existence of natural laws. Through all the self-assertions of human pride, every statesman of experience knows well the reality of the bounds prescribed to political action by the aggregate of social influences, to which he must attribute the failure of the greater number of the projects which he had secretly cherished; and perhaps the conviction is most thorough, while most carefully hidden, in the mind of the most powerful of statesmen, because his inability to struggle against natural laws must be decisive in proportion to his implication with them. Seeing that social science would be impossible in the absence of this principle, we need not dwell further upon it, but may proceed to ascertain the fitness of the new political philosophy to determine, with all the precision that the subject admits, what is the nature of their limits, general or special, permanent or temporary.

Two questions are concerned here: first, in what way the course of human development may be affected by the aggregate of causes of variation which may be applied to it; and next, what share the voluntary and calculated action of our political combinations may have among these modifying influences. The first question is by far the most important, both because it is a general principle, which the second is not, and because it is fully accessible, which, again, the second is not.

Social phenomena modifiable.

We must observe, in the first place, that social phenomena may, from their complexity, be more easily modified than any others, according to the law which was established to that effect on preceding pages. Thus, the limits of variation are wider in regard to sociological than any other laws. If, then, human intervention holds the same proportionate rank among modifying influences as it is natural at first to suppose, its influence must be more considerable in the first case than in the other, all appearances to the contrary notwithstanding. This is the first scientific foundation of all rational hopes of a systematic reformation of humanity; and on this ground illusions of this sort certainly appear more excusable than on any other subject. But though modifications, from all causes, are greater in the case of political than of simpler phenomena, still they can never be more than modifications: that is, they will always be in subjection to those fundamental laws, whether statical or dynamical, which regulate the harmony of the social elements, and the filiation of their successive variations. There is no disturbing influence, exterior or human, which can make incompatible elements co-exist in the political system, nor change in any way the natural laws of the development of humanity. The inevitable gradual preponderance of continuous influences, however imperceptible their power may be at first, is now admitted with regard to all natural phenomena; and it must be applied to social phenomena, whenever the same method of philosophizing is extended to them. What then are the modifications of which the social organism and social life are susceptible, if nothing can alter the laws either of harmony or of succession? The answer is that modifications act upon the intensity and secondary operation of phenomena, but without affecting their nature or their filiation. To suppose that they could, would be to exalt the disturbing above the fundamental cause, and would destroy the whole economy of laws. In the political system this principle of positive philosophy shows that, in a statical view, any possible variations can affect only the intensity of the different tendencies belonging to each social situation, without in any way hindering or producing, or, in a word, changing the nature of, those tendencies; and, in the same way, in a dynamical view, the progress of the race must be considered susceptible of modification only with regard to its speed, and without any reversal in the order of development, or any interval of any importance being overleaped. These variations are analogous to those of the animal organism, with the one difference that in sociology they are more complex; and, as we saw that the limits of variation remain to be established in biology, it is not to be expected that sociology should be more advanced. But all we want here is to obtain a notion of the general spirit of the law, in regard both to social statics and dynamics; and looking at it from both points of view, it seems to me impossible to question its truth. In the intellectual order of phenomena, for instance, there is no accidental influence, nor any individual superiority, which can transfer to one period the discoveries reserved for a subsequent age, in the natural course of the human mind; nor can there be the reverse case of postponement. The history of the sciences settles the question of the close dependence of even the most eminent individual genius on the contemporary state of the human mind; and this is above all remarkable in regard to the improvement of methods of investigation, either in the way of reasoning or experiment. The same thing happens in regard to the arts; and especially in whatever depends on mechanical means in substitution for human action. And there is not, in reality, any more room for doubt in the case of moral development, the character of which is certainly determined, in each period, by the corresponding state of the social evolution, whatever may be the modifications caused by education or individual organization. Each of the leading modes of social existence determines for itself a certain system of morals and manners, the common aspect of which is easily recognised in all individuals, in the midst of their characteristic differences; for instance, there is a state of human life in which the best individual natures contract a habit of ferocity, from which very inferior natures easily emancipate themselves, in a better state of society. The case is the same, in a political point of view, as our historical analysis will hereafter show. And in fact, if we were to review all the facts and reflections which establish the existence of the limits of variation, whose principle I have just laid down, we should find ourselves reproducing in succession all the proofs of the subjection of social phenomena to invariable laws; because the principle is neither more nor less than a strict application of the philosophical conception.

Order of modifying influences.

We can not enlarge upon the second head: that is, the classification of modifying influences according to their respective importance. If such a classification is not yet established in biology, it would be premature indeed to attempt it in social science. Thus, if the three chief causes of social variation appear to me to result from, first, race; secondly, climate; thirdly, political action in its whole scientific extent, it would answer none of our present purposes to inquire here whether this or some other is the real order of their importance. The political influences are the only ones really open to our intervention; and to that head general attention must be directed, though with great care to avoid the conclusion that that class of influences must be the most important because it is the most immediately interesting to us. It is owing to such an illusion as this that observers who believe themselves emancipated from old prejudices can not obtain sociological knowledge, because they enormously exaggerate the power of political action. Because political operations, temporal or spiritual, can have no social efficacy but in as far as they are in accordance with the corresponding tendencies of the human mind, they are supposed to have produced what is in reality occasioned by a spontaneous evolution, which is less conspicuous, and easily overlooked. Such a mistake proceeds in neglect of numerous and marked cases in history, in which the most prodigious political authority has left no lasting traces of its well-sustained development, because it moved in a contrary direction to modern civilization; as in the instances of Julian, of Philip II., of Napoleon Bonaparte, etc. The inverse cases, unhappily too few, are still more decisive; those cases in which political action, sustained by an equally powerful authority, has nevertheless failed in the pursuit of ameliorations that were premature, though in accordance with the social movement of the time. Intellectual history, as well as political, furnishes examples of this kind in abundance. It has been sensibly remarked by Fergusson, that even the action of one nation upon another, whether by conquest or otherwise, though the most intense of all social forces, can effect merely such modifications as are in accordance with its existing tendencies; so that, in fact, the action merely accelerates or extends a development which would have taken place without it. In politics, as in science, *opportuneness* is always the main condition of all great and durable influence, whatever may be the personal value of the superior man to whom the multitude attribute social action of which he is merely the fortunate organ. The power of the individual over the race is subject to these general limits, even when the effects, for good or for evil, are as easy as possible to produce. In revolutionary times, for instance, those who are proud of having aroused anarchical passions in their contemporaries do not see that their miserable triumph is due to a spontaneous disposition, determined by the aggregate of the corresponding social state, which has produced a provisional and partial relaxation of the general harmony. As for the rest, it being ascertained that there are limits of variation among social phenomena, and modifications dependent on systematic political action; and as the scientific principle which is to describe such modifications is now known; the influence and scope of that principle must be determined in each case by the direct development of social science, applied to the appreciation of the corresponding state of circumstances. It is by such estimates, empirically attempted, that men of genius have been guided in all great and profound action upon humanity in any way whatever; and it is only thus that they have been able to rectify, in a rough way, the illusory suggestions of the irrational doctrines in which they were educated. Everywhere, as I have so often said, foresight is the true source of action.

The inaccurate intellectual habits which as yet prevail in political philosophy may induce an apprehension that, according to such considerations as those just presented, the new science of Social Physics may reduce us to mere observation of human events, excluding all continuous intervention. It is, however, certain that, while dissipating all ambitious illusions about the indefinite action of Man on civilization, the principle of rational limits to political action establishes, in the most exact and unquestionable manner, the true point of contact between social theory and practice. It is by this principle only that political art can assume a systematic character, by its release from arbitrary principles mingled with empirical notions. It is thus only that political art can pass upward as medical art has done; the two cases being strongly analogous. As political intervention can have no efficacy unless it rests on corresponding tendencies of the political organism or life, so as to aid its spontaneous development, it is absolutely necessary to understand the natural laws of harmony and succession which determine, in every period, and under every social aspect, what the human evolution is prepared to produce, pointing out, at the same time, the chief obstacles which may be got rid of. It would be exaggerating the scope of such an art to suppose it capable of obviating, in all cases, the violent disturbances which are occasioned by impediments to the natural evolution. In the highly complex social organism, maladies and crises are necessarily even more inevitable than in the individual organism. But, though science is powerless for the moment amidst wild disorder and extravagance, it may palliate and abridge the crises, by understanding their character and foreseeing their issue, and by more or less intervention, where any is possible. Here, as in other cases, and more than in other cases, the office of science is, not to govern, but to modify phenomena; and to do this, it is necessary to understand their laws.

Thus, then, we see what is the function of social science. Without extolling or condemning political facts, science regards them as subjects of observation: it contemplates each phenomenon in its harmony with co-existing phenomena, and in its connection with the foregoing and the following state of human development: it endeavors to discover, from both points of view, the general relations which connected all social phenomena: and each of them is *explained*, in the scientific sense of the word, when it has been connected with the whole of the existing situation, and the whole of the preceding movement. Favoring the social sentiment in the highest degree, this science fulfils the famous suggestion of Pascal, by representing the whole human race, past, present, and future, as constituting a vast and eternal social unit, whose different organs, individual and national, concur, in their various modes and degrees, in the evolution of humanity. Leading us on, like every other science, with as much exactness as the extreme complexity of its phenomena allows, to a systematic prevision of the events which must result from either a given situation or a given aggregate of antecedents, political science enlightens political art, not only in regard to the tendencies which should be aided, but as to the chief means that should be employed, so as to avoid all useless or ephemeral and therefore dangerous action; in short, all waste of any kind of social force.

Means of investigation.

This examination of the general spirit of political philosophy has been much more difficult than the same process in regard to any established science. The next step, now that this is accomplished, is to examine, according to my usual method, the means of investigation proper to Social science. In virtue of a law before recognised, we may expect to find in Sociology a more varied and developed system of resources than in any other, in proportion to the complexity of the phenomena, while yet, this extension of means does not compensate for the increased imperfection arising from the intricacy. The extension of the means is also more difficult to verify than in any prior case, from the novelty of the subject; and I can scarcely hope that such a sketch as I must present here will command such confidence as will arise when a complete survey of the science shall have confirmed what I now offer.

As Social Physics assumes a place in the hierarchy of sciences after all the rest and therefore dependent on them, its means of investigation must be of two kinds: those which are peculiar to itself, and which may be called direct, and those which arise from the connection of sociology with the other sciences; and these last, though indirect, are as indispensable as the first. I shall review, first, the direct resources of the science.

Direct means.

Here, as in all the other cases, there are three methods of proceeding:—by Observation, Experiment, and Comparison.

Observation.

Very imperfect and even vicious notions prevail at present as to what Observation can be and can effect in social science. The chaotic state of doctrine of the last century has extended to Method; and amidst our intellectual disorganization, difficulties have been magnified; precautionary methods, experimental and rational, have been broken up; and even the possibility of obtaining social knowledge by observation has been dogmatically denied; but if the sophisms put forth on this subject were true, they would destroy the certainty, not only of social science, but of all the simpler and more perfect ones that have gone before. The ground of doubt assigned is the uncertainty of human testimony; but all the sciences, up to the most simple, require proofs of testimony: that is, in the elaboration of the most positive theories, we have to admit observations which could not be directly made, nor even repeated, by those who use them, and the reality of which rests only on the faithful testimony of the original investigators; there being nothing in this to prevent the use of such proofs, in concurrence with immediate observations. In astronomy, such a method is obviously necessary; it is equally, though less obviously necessary even in mathematics; and, of course, much more evidently in the case of the more complex sciences. How could any science emerge from the nascent state—how could there be any organization of intellectual labor, even if research were restricted to the utmost, if every one rejected all observations but his own? The stoutest advocates of historical skepticism do not go so far as to advocate this. It is only in the case of social phenomena that the paradox is proposed; and it is made use of there because it is one of the weapons of the philosophical arsenal which the revolutionary metaphysical doctrine constructed for the intellectual overthrow of the ancient political system. The next great hinderance to the use of observation is the empiricism which is introduced into it by those who, in the name of impartiality, would interdict the use of any theory whatever. No logical dogma could be more thoroughly irreconcilable with the spirit of the positive philosophy, or with its special character in regard to the study of social phenomena, than this. No real observation of any kind of phenomena is possible, except in as far as it is first directed, and finally interpreted, by some theory: and it was this logical need which, in the infancy of human reason, occasioned the rise of theological philosophy, as we shall see in the course of our historical survey. The positive philosophy does not dissolve this obligation, but, on the contrary, extends and fulfils it more and more, the further the relations of phenomena are multiplied and perfected by it. Hence it is clear that, scientifically speaking, all isolated, empirical observation is idle, and even radically uncertain; that science can use only those observations which are connected, at least hypothetically, with some law; that it is such a connection which makes the chief difference between scientific and popular observation, embracing the same facts, but contemplating them from different points of view: and that observations empirically conducted can at most supply provisional materials, which must usually undergo an ulterior revision. The rational method of observation becomes more necessary in proportion to the complexity of the phenomena, amid which the observer would not know what he ought to look at in the facts before his eyes, but for the guidance of a preparatory theory; and thus it is that by the connection of foregoing facts we learn to see the facts that follow. This is undisputed with regard to astronomical, physical, and chemical research, and in every branch of biological study, in which good observation of its highly complex phenomena is still very rare, precisely because its positive theories are very imperfect. Carrying on the analogy, it is evident that in the corresponding divisions, statical and dynamical, of social science, there is more need than anywhere else of theories which shall scientifically connect the facts that are happening with those that have happened: and the more we reflect, the more distinctly we shall see that in proportion as known facts are mutually connected we shall be better able, not only to estimate, but to perceive, those which are yet unexplored. I am not blind to the vast difficulty which this requisition imposes on the institution of positive sociology—obliging us to create at once, so to speak, observations and laws, on account of their indispensable connection, placing us in a sort of vicious circle, from which we can issue only by employing in the first instance materials which are badly elaborated, and doctrines which are ill-conceived. How I may succeed in a task so difficult and delicate, we shall see at its close; but, however that may be, it is clear that it is the absence of any positive theory which at present renders social observations so vague and incoherent. There can never be any lack of facts; for in this case even more than in others, it is the commonest sort of facts that are most important, whatever the collectors of secret anecdotes may think; but, though we are steeped to the lips in them, we can make no use of them, nor even be aware of them, for want of speculative guidance in examining them. The statical observation of a crowd of phenomena can not take place without some notion, however elementary, of the laws of social interconnection: and dynamical facts could have no fixed direction if they were not attached, at least by a provisional hypothesis, to the laws of social development. The positive philosophy is very far from discouraging historical or any other erudition; but the precious night-watchings, now so lost in the laborious acquisition of a conscientious but barren learning, may be made available by it for the constitution of true social science, and the increased honor of the earnest minds that are devoted to it. The new philosophy will supply fresh and nobler subjects, unhoped-for insight, a loftier aim, and therefore a higher scientific dignity. It will discard none but aimless labors, without principle and without character; as in Physics, there is no room for compilations of empirical observations; and at the same time, philosophy will render justice to the zeal of students of a past generation, who, destitute of the favorable guidance which we, of this day, enjoy, followed up their laborious historical researches with an instinctive perseverance, and in spite of the superficial disdain of the philosophers of the time. No doubt, the same danger attends research here as elsewhere: the danger that, from the continuous use of scientific theories, the observer may sometimes pervert facts, by erroneously supposing them to verify some ill-grounded speculative prejudices of his own. But we have the same guard here as elsewhere—in the further extension of the science: and the case would not be improved by a recurrence to empirical methods, which would be merely leaving theories that may be misapplied but can always be rectified, for imaginary notions which can not be substantiated at all. Our feeble reason may often fail in the application of positive theories; but at least they transfer us from the domain of imagination to that of reality, and expose us infinitely less than any other kind of doctrine to the danger of seeing in facts that which is not.

It is now clear that social science requires, more than any other, the subordination of Observation to the statical and dynamical laws of phenomena. No social fact can have any scientific meaning till it is connected with some other social fact; without which connection it remains a mere anecdote, involving no rational utility. This condition so far increases the immediate difficulty that good observers will be rare at first, though more abundant than ever as the science expands: and here we meet with another confirmation of what I said at the outset of this volume,—that the formation of social theories should be confided only to the best organized minds, prepared by the most rational training. Explored by such minds, according to rational views of co-existence and succession, social phenomena no doubt admit of much more varied and extensive means of investigation than phenomena of less complexity. In this view, it is not only the immediate inspection or direct description of events that affords useful means of positive exploration; but the consideration of apparently insignificant customs, the appreciation of various kinds of monuments, the analysis and comparison of languages, and a multitude of other resources. In short, a mind suitably trained becomes able by exercise to convert almost all impressions from the events of life into sociological indications, when once the connection of all indications with the leading ideas of the science is understood. This is a facility afforded by the mutual relation of the various aspects of society, which may partly compensate for the difficulty caused by that mutual connection: if it renders observation more difficult, it affords more means for its prosecution.

Experiment.

It might be supposed beforehand that the second method of investigation, Experiment, must be wholly inapplicable in Social Science; but we shall find that the science is not entirely deprived of this resource, though it must be one of inferior value. We must remember (what was before explained) that there are two kinds of experimentation,—the direct and the indirect: and that it is not necessary to the philosophical character of this method that the circumstances of the phenomenon in question should be, as is vulgarly supposed in the learned world, artificially instituted. Whether the case be natural or factitious, experimentation takes place whenever the regular course of the phenomenon is interfered with in any determinate manner. The spontaneous nature of the alteration has no effect on the scientific value of the case, if the elements are known. It is in this sense that experimentation is possible in Sociology. If direct experimentation had become too difficult amidst the complexities of biology, it may well be considered impossible in social science. Any artificial disturbance of any social element must affect all the rest, according to the laws both of co-existence and succession; and the experiment would therefore, if it could be instituted at all, be deprived of all scientific value, through the impossibility of isolating either the conditions or the results of the phenomenon. But we saw, in our survey of biology, that pathological cases are the true scientific equivalent of pure experimentation, and why. The same reasons apply, with even more force, to sociological researches. In them, pathological analysis consists in the examination of cases, unhappily too common, in which the natural laws, either of harmony or of succession, are disturbed by any causes, special or general, accidental or transient; as in revolutionary times especially; and above all, in our own. These disturbances are, in the social body, exactly analogous to diseases in the individual organism: and I have no doubt whatever that the analogy will be more evident (allowance being made for the unequal complexity of the organisms) the deeper the investigation goes. In both cases it is, as I said once before, a noble use to make of our reason, to disclose the real laws of our nature, individual or social, by the analysis of its sufferings. But if the method is imperfectly instituted in regard to biological questions, much more faulty must it be in regard to the phenomena of social science, for want even of the rational conceptions to which they are to be referred. We see the most disastrous political experiments for ever renewed, with only some insignificant and irrational modifications, though their first operation should have fully satisfied us of the uselessness and danger of the expedients proposed. Without forgetting how much is ascribable to the influence of human passions, we must remember that the deficiency of an authoritative rational analysis is one of the main causes of the barrenness imputed to social experiments, the course of which would become much more instructive if it were better observed. The great natural laws exist and act in all conditions of the organism; for, as we saw in the case of biology, it is an error to suppose that they are violated or suspended in the case of disease: and we are therefore justified in drawing our conclusions, with due caution, from the scientific analysis of disturbance to the positive theory of normal existence. This is the nature and character of the indirect experimentation which discloses the real economy of the social body in a more marked manner than simple observation could do. It is applicable to all orders of sociological research, whether relating to existence or to movement, and regarded under any aspect whatever, physical, intellectual, moral or political; and to all degrees of the social evolution, from which, unhappily, disturbances have never been absent. As for its present extension, no one can venture to offer any statement of it, because it has never been duly applied in any investigation in political philosophy; and it can become customary only by the institution of the new science which I am endeavoring to establish. But I could not omit this notice of it, as one of the means of investigation proper to social science.

Comparison.

As for the third of those methods, Comparison, the reader must bear in mind the explanations offered, in our survey of biological philosophy, of the reasons why the comparative method must prevail in all studies of which the living organism is the subject; and the more remarkably, in proportion to the rank of the organism. The same considerations apply in the present case, in a more conspicuous degree; and I may leave it to the reader to make the application, merely pointing out the chief differences which distinguish the use of the comparative method in sociological inquiries.

Comparison with inferior animals.

It is a very irrational disdain which makes us object to all comparison between human society and the social state of the lower animals. This unphilosophical pride arose out of the protracted influence of the theologico-metaphysical philosophy; and it will be corrected by the positive philosophy, when we better understand and can estimate the social state of the higher orders of mammifers, for instance. We have seen how important is the study of individual life, in regard to intellectual and moral phenomena,—of which social phenomena are the natural result and complement. There was once the same blindness to the importance of the procedure in this case as now in the other; and as it has given way in the one case, so it will in the other. The chief defect in the kind of sociological comparison that we want is that it is limited to statical considerations; whereas the dynamical are, at the present time, the preponderant and direct subject of science. The restriction results from the social state of animals being, though not so stationary as we are apt to suppose, yet susceptible only of extremely small variations, in no way comparable to the continued progression of humanity in its feeblest days. But there is no doubt of the scientific utility of such a comparison, in the statical province, where it characterizes the elementary laws of social interconnection, by exhibiting their action in the most imperfect state of society, so as even to suggest useful inductions in regard to human society. There can not be a stronger evidence of the natural character of the chief social relations, which some people fancy that they can transform at pleasure. Such sophists will cease to regard the great ties of the human family as factitious and arbitrary when they find them existing, with the same essential characteristics, among the animals, and more conspicuously, the nearer the organisms approach to the human type. In brief, in all that part of sociology which is almost one with intellectual and moral biology, or with the natural history of Man; in all that relates to the first germs of the social relations, and the first institutions which were founded by the unity of the family or the tribe, there is not only great scientific advantage, but real philosophical necessity for employing the rational comparison of human with other animal societies. Perhaps it might even be desirable not to confine the comparison to societies which present a character of voluntary co-operation, in analogy to the human. They must always rank first in importance: but the scientific spirit, extending the process to its final logical term, might find some advantage in examining those strange associations, proper to the inferior animals, in which an involuntary co-operation results from an indissoluble organic union, either by simple adhesion or real continuity. If the science gained nothing by this extension, the method would. And there is nothing that can compare with such an habitual scientific comparison for the great service of casting out the absolute spirit which is the chief vice of political philosophy. It appears to me, moreover, that, in a practical view, the insolent pride which induces some ranks of society to suppose themselves as, in a manner, of another species than the rest of mankind, is in close affinity with the irrational disdain that repudiates all comparison between human and other animal nature. However all this may be, these considerations apply only to a methodical and special treatment of social philosophy. Here, where I can offer only the first conception of the science, in which dynamical considerations must prevail, it is evident that I can make little use of the kind of comparison; and this makes it all the more necessary to point it out, lest its omission should occasion such scientific inconveniences as I have just indicated. The commonest logical procedures are generally so characterized by their very application, that nothing more of a preliminary nature is needed than the simplest examination of their fundamental properties.

Comparison of coexisting states of society.

To indicate the order of importance of the forms of society which are to be studied by the Comparative Method, I begin with the chief method, which consists in a comparison of the different coexisting states of human society on the various parts of the earth's surface,—those states being completely independent of each other. By this method, the different stages of evolution may all be observed at once. Though the progression is single and uniform, in regard to the whole race, some very considerable and very various populations have, from causes which are little understood, attained extremely unequal degrees of development, so that the former states of the most civilized nations are now to be seen, amid some partial differences, among contemporary populations inhabiting different parts of the globe. In its relation to Observation, this kind of comparison offers the advantage of being applicable both to statical and dynamical inquiries, verifying the laws of both, and even furnishing occasionally valuable direct inductions in regard to both. In the second place, it exhibits all possible degrees of social evolution to our immediate observation. From the wretched inhabitants of Tierra del Fuego to the most advanced nations of western Europe, there is no social grade which is not extant in some points of the globe, and usually in localities which are clearly apart. In the historical part of this work, we shall find that some interesting secondary phases of social development, of which the history of civilization leaves no perceptible traces, can be known only by this comparative method of study; and these are not, as might be supposed, the lowest degrees of evolution, which every one admits can be investigated in no other way. And between the great historical aspects, there are numerous intermediate states which must be observed thus, if at all. This second part of the comparative method verifies the indications afforded by historical analysis, and fills up the gaps it leaves: and nothing can be more rational than the method, as it rests upon the established principle that the development of the human mind is uniform in the midst of all diversities of climate, and even of race; such diversities having no effect upon anything more than the rate of progress. But we must beware of the scientific dangers attending the process of comparison by this method. For instance, it can give us no idea of the order of succession, as it presents all the states of development as coexisting: so that, if the order of development were not established by other methods, this one would infallibly mislead us. And again, if we were not misled as to the order, there is nothing in this method which discloses the filiation of the different systems of society; a matter in which the most distinguished philosophers have been mistaken in various ways and degrees. Again, there is the danger of mistaking modifications for primary phases; as when social differences have been ascribed to the political influence of climate, instead of that inequality of evolution which is the real cause. Sometimes, but more rarely, the mistake is the other way. Indeed, there is nothing in the matter that can show which of two cases presents the diversity that is observed. We are in danger of the same mistake in regard to races; for, as the sociological comparison is instituted between peoples of different races, we are liable to confound the effects of race and of the social period. Again, climate comes in to offer a third source of interpretation of comparative phenomena, sometimes agreeing with, and sometimes contradicting the two others; thus multiplying the chances of error, and rendering the analysis which looked so promising almost impracticable. Here, again, we see the indispensable necessity of keeping in view the positive conception of human development as a whole. By this alone can we be preserved from such errors as I have referred to, and enriched by any genuine results of analysis. We see how absurd in theory and dangerous in practice are the notions and declamations of the empirical school, and of the enemies of all social speculation: for it is precisely in proportion to their elevation and generality that the ideas of positive social philosophy becomes real and effective,—all illusion and uselessness belonging to conceptions which are too narrow and too special, in the departments either of science or of reasoning. But it is a consequence from these last considerations that this first sketch of sociological science, with the means of investigation that belong to it, rests immediately upon the primary use of a new method of observation, which is so appropriate to the nature of the phenomena as to be exempt from the dangers inherent in the others. This last portion of the comparative method is the Historical Method, properly so called; and it is the only basis on which the system of political logic can rest.

Comparison of consecutive states.

The historical comparison of the consecutive states of humanity is not only the chief scientific device of the new political philosophy. Its rational development constitutes the substratum of the science, in whatever is essential to it. It is this which distinguishes it thoroughly from biological science, as we shall presently see. The positive principle of this separation results from the necessary influence of human generations upon the generations that follow, accumulating continuously till it constitutes the preponderating consideration in the direct study of social development. As long as this preponderance is not directly recognised, the positive study of humanity must appear a simple prolongation of the natural history of Man: but this scientific character, suitable enough to the earlier generations, disappears in the course of the social evolution, and assumes at length a wholly new aspect, proper to sociological science, in which historical considerations are of immediate importance. And this preponderant use of the historical method gives its philosophical character to sociology in a logical as well as a scientific sense. By the creation of this new department of the comparative method, sociology confers a benefit on the whole of natural philosophy; because the positive method is thus completed and perfected, in a manner which, for scientific importance, is almost beyond our estimate. What we can now comprehend is that the historical method verifies and applies, in tbe largest way, that chief quality of sociological science,—its proceeding from the whole to the parts. Without this permanent condition of social study, all historical labor would degenerate into being a mere compilation of provisional materials. As it is in their development, especially, that the various social elements are interconnected and inseparable, it is clear that any partial filiation must be essentially untrue. Where, for instance, is the use of any exclusive history of any one science or art, unless meaning is given to it by first connecting it with the study of human progress generally? It is the same in every direction, and especially with regard to political history, as it is called; as if any history could be other than political, more or less! The prevailing tendency to speciality in study would reduce history to a mere accumulation of unconnected delineations, in which all idea of the true filiation of events would be lost amid the mass of confused descriptions. If the historical comparisons of the different periods of civilization are to have any scientific character, they must be referred to the general social evolution: and it is only thus that we can obtain the guiding ideas by which the special studies themselves must be directed.

In a practical view, it is evident that the preponderance of the historical method tends to develop the social sentiment, by giving us an immediate interest in even the earliest experiences of our race, through the influence that they exercised over the evolution of our own civilization. As Condorcet observed, no enlightened man can think of the battles of Marathon and Salamis without perceiving the importance of their consequences to the race at large. This kind of feeling should, when we are treating of science, be carefully distinguished from the sympathetic interest which is awakened by all delineations of human life,—in fiction as well as in history. The sentiment I refer to is deeper, because in some sort personal; and more reflective, because it results from scientific conviction. It can not be excited by popular history, in a descriptive form; but only by positive history, regarded as a true science, and exhibiting the events of human experience in co-ordinated series which manifest their own graduated connection. This new form of the social sentiment must at first be the privilege of the choice few; but it will be extended, somewhat weakened in force, to the whole of society, in proportion as the general results of social physics become sufficiently popular. It will fulfil the most obvious and elementary idea of the habitual connection between individuals and contemporary nations, by showing that the successive generations of men concur in a final end, which requires the determinate participation of each and all. This rational disposition to regard men of all times as fellow-workers is as yet visible in the case of only the most advanced sciences. By the philosophical preponderance of the historical method, it will be extended to all the aspects of human life, so as to sustain, in a reflective temper, that respect for our ancestors which is indispensable to a sound state of society, and so deeply disturbed at present by the metaphysical philosophy.

As for the course to be pursued by this method,—it appears to me that its spirit consists in the rational use of social series; that is, in a successive estimate of the different states of humanity which shall show the growth of each disposition, physical, intellectual, moral, or political, combined with the decline of the opposite disposition, whence we may obtain a scientific prevision of the final ascendency of the one and extinction of the other,—care being taken to frame our conclusions according to the laws of human development. A considerable accuracy of prevision may thus be obtained, for any determinate period, and with any particular view; as historical analysis will indicate the direction of modifications, even in the most disturbed times. And it is worth noticing that the prevision will be nearest the truth in proportion as the phenomena in question are more important and more general; because then continuous causes are predominant in the social movement; and disturbances have less power. From these first general aspects, the same rational certainty may extend to secondary and special aspects, through their statical relations with the first; and thus we may obtain conclusions sufficiently accurate for the application of principles.

If we desire to familiarize ourselves with this historical method, we must employ it first upon the past, by endeavoring to deduce every well-known historical situation from the whole series of its antecedents. In every science we must have learned to predict the past, so to speak, before we can predict the future; because the first use of the observed relations among fulfilled facts is to teach us by the anterior succession what the future succession will be. No examination of facts can explain our existing state to us, if we have not ascertained, by historical study, the value of the elements at work; and thus it is in vain that statesmen insist on the necessity of political observation, while they look no further than the present, or a very recent past. The present is, by itself, purely misleading, because it is impossible to avoid confounding principal with secondary facts, exalting conspicuous transient manifestations over fundamental tendencies, which are generally very quiet; and above all, supposing those powers, institutions, and doctrines, to be in the ascendant, which are, in fact, in their decline. It is clear that the only adequate corrective of all this is a philosophical understanding of the past; that the comparison can not be decisive unless it embraces the whole of the past; and that the sooner we stop, in travelling up the vista of time, the more serious will be the mistakes we fall into. Before our very eyes, we see statesmen going no farther back than the last century, to obtain an explanation of the confusion in which we are living: the most abstract of politicians may take in the preceding century, but the philosophers themselves hardly venture beyond the sixteenth; so that those who are striving to find the issue of the revolutionary period have actually no conception of it as a whole, though that whole is itself only a transient phase of the general social movement.

The most perfect methods may, however, be rendered deceptive by misuse: and this we must bear in mind. We have seen that mathematical analysis itself may betray us into substituting signs for ideas, and that it conceals inanity of conception under an imposing verbiage. The difficulty in the case of the historical method in sociology is in applying it, on account of the extreme complexity of the materials we have to deal with. But for this, the method would be entirely safe. The chief danger is of our supposing a continuous decrease to indicate a final extinction, or the reverse; as in mathematics it is a common sophism to confound continuous variations, more or less, with unlimited variations. To take a strange and very marked example: if we consider that part of social development which relates to human food, we can not but observe that men take less fŏod as they advance in civilization. If we compare savage with more civilized peoples, in the Homeric poems or in the narratives of travellers, or compare country with town life, or any generation with the one that went before, we shall find this curious result,—the sociological law of which we shall examine hereafter. The laws of individual human nature aid in the result by making intellectual and moral action more preponderant as Man becomes more civilized. The fact is thus established, both by the experimental and the logical way. Yet nobody supposes that men will ultimately cease to eat. In this case, the absurdity saves us from a false conclusion; but in other cases, the complexity disguises much error in the experiment and the reasoning. In the above instance, we must resort to the laws of our nature for that verification which, taken all together, they afford to our sociological analysis. As the social phenomenon, taken as a whole, is simply a development of humanity, without any real creation of faculties, all social manifestations must be to be found, if only in their germ, in the primitive type which biology constructed by anticipation for sociology. Thus every law of social succession disclosed by the historical method must be unquestionably connected, directly or indirectly, with the positive theory of human nature; and all inductions which can not stand this test will prove to be illusory, through some sort of insufficiency in the observations on which they are grounded. The main scientific strength of sociological demonstrations must ever lie in the accordance between the conclusions of historical analysis and the preparatory conceptions of the biological theory. And thus we find, look where we will, a confirmation of that chief intellectual character of the new science,—the philosophical preponderance of the spirit of the whole over the spirit of detail.

This method ranks, in sociological science, with that of zoological comparison in the study of individual life; and we shall see, as we proceed, that the succession of social states exactly corresponds, in a scientific sense, with the gradation of organisms in biology; and the social series, once clearly established, must be as real and as useful as the animal series. When the method has been used long enough to disclose its properties, I am disposed to think that it will be regarded as so very marked a modification of positive research as to deserve a separate place; so that, in addition to Observation, properly so called, Experiment, and Com-

Promise of a fourth method

parison, we shall have the Historical Method, as a fourth and final mode of the art of observing. It will be derived, according to the usual course, from the mode which immediately precedes it: and it will be applied to the analysis of the most complex phenomena.

I must be allowed to point out that the new political philosophy, sanctioning the old leadings of popular reason, restores to History all its scientific rights as a basis of wise social speculation, after the metaphysical philosophy had striven to induce us to discard all large consideration of the past. In the foregoing departments of natural philosophy we have seen that the positive spirit, instead of being disturbing in its tendencies, is remarkable for confirming, in the essential parts of every science, the inestimable intuitions of popular good sense; of which indeed science is merely a systematic prolongation, and which a barren metaphysical philosophy alone could despise. In this case, so far from restricting the influence which human reason has ever attributed to history in political combinations, the new social philosophy increases it, radically and eminently. It asks from history something more than counsel and instruction to perfect conceptions which are derived from another source: it seeks its own general direction, through the whole system of historical conclusions.

Having reviewed the general character of Sociology, and its means of investigation, we must next make out its relations to the other principal sciences.

CHAPTER IV.

RELATION OF SOCIOLOGY TO THE OTHER DEPARTMENTS OF POSITIVE PHILOSOPHY.

The conditions of the positive philosophy with regard to this science are not fulfilled till its relations with the other sciences are ascertained. Its establishment in its proper place in the hierarchy is a principle of such importance that it may be seen to comprehend all the philosophical requisities for its institution as a science: and it is for want of this that all attempts in our time to treat social questions in a positive manner have failed. Whether we consider the indispensable data of various kinds supplied to sociology by the other sciences, or the yet more important requisite of the sound speculative habits formed by the preparatory study of them, the daily spectacle of abortive attempts to construct a social science leaves no doubt that this grand omission is the cause of the failure, and of the wrong direction always taken, sooner or later, by minds which seemed fitted to accomplish something better. We must, then, review the relation of this last of the sciences to all the rest;

but our examination of each of them, and of biology especially, has so anticipated this part of my subject, that I may pass over it very briefly.

It is a new idea that the science of society is thus connected with the rest: yet in no case is the relation more unquestionable or more marked. Social phenomena exhibit, in even a higher degree, the complexity, speciality, and personality which distinguish the higher phenomena of the individual life. In order to see how this establishes the connection in question, we must remember that in the social, as in the biological case, there are two classes of considerations:—that of Man or Humanity, which constitutes the phenomenon, and that of the medium or environment, which influences this partial and secondary development of one of the animal races. Now, by the first term of this couple, sociology is subordinated to the whole of the organic philosophy, which discloses to us the laws of human nature: and by the second, it is connected with the whole system of inorganic philosophy, which reveals to us the exterior conditions of human existence. One of the two great divisions of philosophy, in short, determines the agent concerned in sociological phenomena, and the other the medium in which it is developed. It is clear that we here take together, and treat as one, the three sections of inorganic philosophy,—chemistry, physics, and astronomy,—as they all relate equally to the social medium. It will be enough if we point out the participation of each, as the occasion arises. As to the Method, properly so called, it is, as we have seen, more and more necessary to subject studies to the graduated system of prior studies, in proportion to their increasing complexity. These are the two points we have to consider in surveying once more the encyclopedical scale, beginning, as before, with the relations which are the closest and most direct. We shall afterward have to exhibit the reaction, scientific and logical, which sociology, once instituted, must exercise, in its turn, on the whole of the preceding sciences:—a reaction which is, as yet, even less suspected than the primary action itself.

Relation to Biology.

The subordination of social science to biology is so evident that nobody denies it in statement, however it may be neglected in practice. This contrariety between the statement and the practice is due to something else, besides the faulty condition of social studies: it results also from the imperfection of biological science; and especially from its most conspicuous imperfection of all,—that of its highest part, relating to intellectual and moral phenomena. It is by this portion that biology and sociology are the most closely connected; and cerebral physiology is too recent, and its scientific state is too immature, to have admitted, as yet, of any proper organization of the relations of the two sciences. Whenever the time for that process arrives, the connection will be seen to bear two aspects. Under the first, biology will be seen to afford the starting-point of all social speculation, in accordance with the analysis of the social faculties of Man, and of the organic conditions which determine its character. But, moreover, as we can scarcely at all investigate the most elementary terms of the social series, we must construct them by applying the positive theory of human nature to the aggregate of corresponding circumstances,—regarding the small materials that we are able to obtain as rather adapted to facilitate and improve this rational determination than to show us what society really is at so early a period. When the social condition has advanced so far as to exclude this kind of deduction, the second aspect presents itself; and the biological theory of man is implicated with the sociological in a less direct and special manner. The whole social evolution of the race must proceed in entire accordance with biological laws; and social phenomena must always be founded on the necessary invariableness of the human organism, the characteristics of which, physical, intellectual, and moral, are always found to be essentially the same, and related in the same manner, at every degree of the social scale,—no development of them attendant upon the social condition ever altering their nature in the least, nor, of course, creating or destroying any faculties whatever, or transposing their influence. No sociological view can therefore be admitted, at any stage of the science, or under any appearance of historical induction, that is contradictory to the known laws of human nature. No view can be admitted, for instance, which supposes a very marked character of goodness or wickedness to exist in the majority of man; or which represents the sympathetic affections as prevailing over the personal ones; or the intellectual over the affective faculties, etc. In cases like these, which are more common than the imperfection of the biological theory would lead us to expect, all sociological principles must be as carefully submitted to ulterior correction as if they supposed human life to be extravagantly long, or contravened, in any other way, the physical laws of humanity; because the intellectual and moral conditions of human existence are as real and as imperative as its material condition, though more difficult to estimate, and therefore less known. Thus, in a biological view, all existing political doctrines are radically vicious, because, in their irrational estimate of political phenomena, they suppose qualities to exist among rulers and the ruled,—here an habitual perverseness or imbecility, and there a spirit of concert or calculation, —which are incompatible with positive ideas of human nature, and which would impute pathological monstrosity to whole classes; which is simply absurd. An example like this shows what valuable resources positive sociology must derive from its subordination to biology; and especially in regard to cerebral physiology, whenever it comes to be studied as it ought.

The students of biology have, however, the same tendency to exalt their own science at the expense of that which follows it that physicists and chemists have shown in regard to biology. The biologists lose sight of historical observation altogether, and represent sociology as a mere corollary of the science of Man; in the same way that physicists and chemists treat biology as a mere derivative from the inorganic philosophy. The injury to science is great in both cases. If we neglect historical comparison, we can understand nothing of the social evolution; and the chief phenomenon in sociology,—the phenomenon which marks its scientific originality,—that is, the gradual and continuous influence of generations upon each other,—would be disguised or unnoticed, for want of the necessary key—historical analysis. From the time that the influence of former generations becomes the cause of any modification of the social movement, the mode of investigation must accord with the nature of the phenomena; and historical analysis therefore becomes preponderant, while biological considerations, which explained the earliest movements of society, cease to be more than a valuable auxiliary and means of control. It is the same thing as when, in the study of inorganic science, men quit deduction for direct observation. It is the same thing as when, in biology, observers proceed from contemplating the organism and its medium, to analyze the ages of the individual being, as a principal means of investigation. The only difference is that the change in the instrument is the more necessary the more complex are the the phenomena to be studied. This would have been seen at once, and political philosophy would have been admitted to depend on this condition for its advance, but for the prevalence of the vicious absolute spirit in social speculation, which, neglecting the facts of the case, for ever strives to subject social considerations to the absolute conception of an immutable political type, no less adverse to the relative spirit of positive philosophy than theological and metaphysical types, though less indefinite. The consequence of this error is that social modifications proper to certain periods, and passing away with them, are too often supposed to be inherent in human nature, and therefore indestructible. Even Gall, attending only to imperfect physiological considerations, and neglecting the social, wandered off into a sort of scientific declamation on the subject of war, declaring the military tendencies of mankind to be immutable, notwithstanding the mass of historical testimony which shows that the warlike disposition diminishes as human development proceeds. A multitude of examples of this kind of mistake might be presented; the most striking of which are perhaps in connection with theories of education, which are usually formed on absolute principles, to the neglect of the corresponding state of civilization.

The true nature of sociology is evident enough from what has been said. We see that it is not an appendix to biology, but a science by itself, founded upon a distinct basis, while closely connected, from first to last, with biology. Such is the scientific view of it. As to the method, the logical analogy of the two sciences is so clear as to leave no doubt that social philosophers must prepare their understandings for their work by due discipline in biological methods. This is necessary, not only to put them in possession of the general spirit of investigation proper to organic science, but yet more to familiarize them with the comparative method, which is the grand resource of investigation in both sciences. Moreover, there is a most valuable philosophical principle common to both sciences, which remains to be fully developed before it can attain its final prevalence;—I mean the positive version of the dogma of final causes, discussed before in connection with the conditions of vital existence. This principle, being the necessary result of the distinction between the statical and the dynamical condition, belongs eminently to the study of living bodies, in which that distinction is especially marked, and where alone the general idea of it can properly be acquired. But, great as is its direct use in the study of individual life, it is applicable in a much more extensive and essential way in social science. It is by means of this principle that the new philosophy, uniting the two philosophical meanings of the word *necessary*, exhibits as inevitable that which first presents itself as indispensable; and the converse. There must be something in it peculiarly in harmony with social investigations, as we are led up to it by the most opposite methods of approach; one evidence of which is De Maistre's fine political aphorism, "Whatever is necessary exists."

Relation to Inorganic philosophy.

If sociology is thus subordinated to biology, it must be scientifically related to the whole system of inorganic philosophy, because biology is so. But it is also connected with that system by immediate relations of its own.

In the first place, it is only by the inorganic philosophy that we can duly analyze the entire system of exterior conditions, chemical, physical, and astronomical, amidst which the social evolution proceeds, and by which its rate of progress is determined. Social phenomena can no more be understood apart from their environment than those of individual life. All exterior disturbances which could affect the life of individual Man must change his social existence; and, conversely, his social existence could not be seriously disturbed by any modifications of the medium which should not derange his separate condition. I need therefore only refer to what I have said in regard to the influence of astronomical and other conditions on vital existence; for the same considerations bear on the case of social phenomena. It is plain that society, as well as individual beings, is affected by the circumstances of the earth's daily rotation and annual movement; and by states of heat, moisture, and electricity, in the surrounding medium; and by the chemical conditions of the atmosphere, the waters, the soil, etc. I need only observe that the effect of these influences is even more marked in sociology than in biology, not only because the organism is more complex, and its phenomena of a higher order, but because the social organism is regarded as susceptible of indefinite duration, so as to render sensible many gradual modifications which would be disguised from our notice by the brevity of individual life. Astronomical conditions, above all others, manifest their importance to living beings only by passing from the individual to the social case. Much smaller disturbances would visibly affect a social condition than would disturb an individual life, which requires a smaller concurrence of favorable circumstances. For instance, the dimensions of the globe are scientifically more important in sociology than in biology, because they set bounds to the ultimate extension of population; a circumstance worthy of grave consideration in any positive system of political speculation. And this is only one case of very many. If we consider, in regard to dynamical conditions, what would be the effect of any change in the degree of obliquity of the ecliptic, in the stability of the poles of rotation, and yet more in the eccentricity of the earth's orbit, we shall see that vast changes in social life must be produced by causes which could not endanger individual existence. One of the first reflections that presents itself is that positive sociology was not possible till the inorganic philosophy had reached a certain degree of precision. The very conception of stability in human association could not be positively established till the discovery of gravitation had assured us of the permanence of the conditions of life; and till physics and chemistry had taught us that the surface of our planet had attained a natural condition, apart from accidents too rare and too partial to affect our estimate; or, at least, that the crust of the globe admits of only variations so limited and so gradual as not to interfere with the natural course of social development—a development which could not be hoped for under any liability to violent and frequent physico-chemical convulsions of any extent in the area of human life. There is thus more room to apprehend that inorganic philosophy is not advanced enough to supply the conditions of a positive polity, than to suppose that any real political philosophy can be framed in independence of inorganic science. We have seen before, however, that there is a perpetual accordance between the possible and the indispensable. What we must have, we are able to obtain; and if there are, as in the case of the mutual action of different starry systems, cosmical ideas which are inaccessible to us, we know, in regard to sociology now, as to biology before, that they are of no practical importance to us. Wherever we look, over the whole field of science, we shall find that, amidst the great imperfection of inorganic philosophy, it is sufficiently advanced, in all essential respects, to contribute to the constitution of true social science, if we only have the prudence to postpone to a future time investigations which would now be premature.

I observed in a former chapter that no disturbing causes, acting on social development, could do more than affect its rate of progress. This is true of the operation of influences from the inorganic world, as of all others. In our review of biology we saw that the human being can not be modified indefinitely by exterior circumstances; that such modifications can affect only the degrees of phenomena, without at all changing their nature; and again, that when the disturbing influences exceed their general limits, the organism is no longer modified, but destroyed. All this is, if possible, more eminently true of the social than of the individual organism, on account of its higher complexity and position. The course of its development must therefore be regarded as belonging to the essence of the phenomenon itself, and therefore essentially identical in all conceivable hypotheses about the corresponding medium. It is true we can easily imagine, as I said just now, that so delicate an evolution may be prevented by external disturbances, and particularly astronomical perturbations, which would not destroy the race; but as long as the evolution does proceed, it must be supposed subject to the same essential laws, and varying only in its speed, as it traverses the stages of which it is composed, without their succession or their final tendency being ever changed. Such a change would be beyond the power of even biological causes If, for instance, we admitted some marked alterations in the human organism, or, what comes to the same thing, conceived of the social development of another animal race, we must always suppose a common course of general development. Such is the philosophical condition imposed by the nature of the subject, which could not become positive, except in as far as it could be thus conceived of; and this is much more conspicuously true in regard to inorganic causes. As to the rest, this is only another illustration of what we have so often seen in the course of our survey of the scientific hierarchy—that if the less general phenomena occur under the necessary preponderance of the more general, this subordination can not in any way alter their proper laws, but only the extent and duration of their real manifestations.

Man's action on the external world.

One consideration remains, of the more importance because it applies especially to physico-chemical knowledge, which we seem to have rather neglected in this sketch for astronomical doctrine: I mean the consideration of Man's action on the external world, the gradual development of which affords one of the chief aspects of the social evolution, and without which the evolution could not have taken place as a whole, as it would have been stopped at once by the preponderance of the material obstacles proper to the human condition. In short, all human progress, political, moral, or intellectual, is inseparable from material progression, in virtue of the close interconnection which, as we have seen, characterizes the natural course of social phenomena. Now, it is clear that the action of man upon nature depends chiefly on his knowledge of the laws of inorganic phenomena, though biological phenomena must also find a place in it. We must bear in mind, too, that physics, and yet more chemistry, form the basis of human power, since astronomy, notwithstanding its eminent participation in it, concurs not as an instrument for modifying the medium, but by prevision. Here we have another ground on which to exhibit the impossibility of any rational study of social development otherwise than by combining sociological speculations with the whole of the doctrines of inorganic philosophy.

Necessary Education.

It can not be necessary to repeat here that which has been established as true with regard to the other sciences, and which is more conspicuously true as each science becomes more complex—that an adequate general knowledge of all the preceding sciences in the hierarchy is requisite to the understanding of the one that follows. In the case of sociology the absence of this preparation is the obvious cause of the failure of all attempts to regenerate the science. We desire to recognise in it a positive science, while we leave the conditions of positivity unfulfilled. We do not even form a just idea of the attributes of positivism, of what constitutes the explanation of a phenomenon, of the conditions of genuine investigation, or of the true intention in which hypotheses should be instituted and employed. We must thoroughly understand all these conditions, and use them in the natural order of the development of the sciences, venturing neither to select nor transpose, but following up the increasing complexity of the sciences, and recognising the increase of resources which accompanies it, from astronomy with its simplicity of phenomena and of means of research, to sociology with its prodigious complexity and abundance of resources. Such discipline as this may be difficult; but it is indispensable. It is the only preparatory education which can introduce the positive spirit into the formation of social theories.

Mathematical preparation.

It is clear that this education must rest on a basis of mathematical philosophy, even apart from the necessity of mathematics to the study of inorganic philosophy. It is only in the region of mathematics that sociologists, or anybody else, can obtain a true sense of scientific evidence, and form the habit of rational and decisive argumentation; can, in short, learn to fulfil the logical conditions of all positive speculation, by studying universal positivism at its source. This training, obtained and employed with the more care on account of the eminent difficulty of social science, is what sociologists have to seek in mathematics. As for any application of number and of a mathematical law to sociological problems, if such a method is inadmissible in biology, it must be yet more decisively so here, for reasons of which I have already said enough. The only error of this class which would have deserved express notice, if we had not condemned it by anticipation, is the pretension of some geometers to render social investigations positive by subjecting them to a fanciful mathematical theory of chances. This error is in analogy with that of biologists who would make sociology to be a corollary or appendix to their own science by suppressing the function of historical analysis. The error of the geometers is however by far the worst of the two, in itself, as well as because mathematicians are peculiarly tenacious of error, from the abstract character of their labors, which dispenses them from the close study of nature. Gross as is the illusion, we must remember its excusable origin. It was James Bernouilli who first conceived the notion; and the notion affords evidence of the nascent need to subject social theories to

Pretended theory of chances.

some kind of positivity. None but a high order of mind could have so early felt the need; and if the expedient was vicious, there was no better way discernible by any possibility at that time. The error was much less pardonable when the notion was reproduced by Condorcet, in a more direct and systematic way; and his expectation from it, as manifested in his celebrated posthumous work, shows the fluctuating state of his mind in regard to the primary conception of social science. But there is no excuse for Laplace's repetition of such a philosophical mistake, at a time when the general human mind had begun to discern the true spirit of political philosophy, prepared as it was for the disclosure by the labors of Montesquieu, and Condorcet himself, and powerfully stimulated besides by a new convulsion of society. From that time a succession of imitators has gone on repeating the fancy, in heavy algebraic language, without adding anything new, abusing the credit which justly belongs to the true mathematical spirit; so that, instead of being, as it was a century ago, a token of a premature instinct of scientific investigation, this error is now only an involuntary testimony to the absolute impotence of the political philosophy that would employ it. It is impossible to conceive of a more irrational conception than that which takes for its basis or for its operative method a supposed mathematical theory, in which, signs being taken for ideas, we subject numerical probability to calculation, which amounts to the same thing as offering our own ignorance as the natural measure of the degree of probability of our various opinions. While true mathematical theories have made great progress, for a century past, this absurd doctrine has undergone no improvement, except in some matters of abstract calculation which it has given rise to. It still abides in the midst of its circle of original errors, while mankind are learning, more and more, that the strongest proof of the reality of speculation in any science whatever is the fruitfulness of the conceptions belonging to it.

It is with a feeling of shame that I revert so often to the great maxims of philosophical pursuit, and dwell on them so long; that I should have to announce at this time of day that we must study simpler phenomena before proceeding to the more complex; and that we should acquaint ourselves with the agent of any phenomenon, and with the medium or circumstances, before we proceed to analyze it. But so different has been the course of political study pursued in the metaphysical school, that I rather apprehend that this high scientific connection will be exactly the part of my philosophical doctrine which will be least appreciated, and perhaps most contested, even after all the confirmation which I am about to offer. The reason of this apprehension is that the positive method is in direct opposition to our political habit of appealing to all sorts of minds on social questions, which they are expected to judge of, without any regular preparation, as if these problems were occasions for inspired decision. It is this consideration which makes me attach so special an importance to an explanation of the relation of Sociology to the other sciences.

Reaction of Sociology.

To complete the account of these encyclopedic relations, we must look at the connection in an inverse way, estimating the philosophical reaction of social physics on all the foregoing sciences, in regard both to doctrine and method.—It must be at the end of the work that I must treat of Sociology as completing the whole body of philosophy, and showing that the various sciences are branches from a single trunk; and thereby giving a character of unity to the variety of special studies that are now scattered abroad in a fatal dispersion. In this place I can only point out, in a more special manner, the immediate reaction of Sociology on all the rest of natural philosophy in virtue of its own scientific and logical properties.

As to doctrine.

In regard to the doctrine, the essential principle of this reaction is found in the consideration that all scientific speculations whatever, in as far as they are human labors, must necessarily be subordinated to the true general theory of human evolution. If we could conceive of such a thing as this theory being so perfected as that no intellectual obstacle should limit the abundance of its most exact deductions, it is clear that the scientific hierarchy would be, as it were, inverted, and would present the different sciences, in an *à priori* way, as mere parts of this single science. We have no power to realize such a state of things; but the mere supposition may enable us to comprehend the legitimate general intervention of true social science in all possible classes of human speculation. At first sight, it appears as if this high intervention must belong to the biological theory of our nature; and it was by that avenue that philosophers first caught a glimpse of the conception: and it is perfectly true that the knowledge of the individual man must exert a secret but inevitable influence over all the sciences, because our labors bear the ineffaceable impress of the faculties which produce them. But a close examination will convince us that this universal influence must belong more to the theory of social evolution than to that of individual Man, for the reason that the development of the human mind can take place only through the social state, the direct consideration of which must therefore prevail whenever we are treating of any results of that development. This is, then, in the briefest form, the first philosophical ground of the intellectual intervention of social physics in the cultivation of all the parts of natural philosophy. There will be more to say about it hereafter.

It is evident that Sociology must perfect the study of the essential relations which unite the different sciences, as this inquiry constitutes an essential part of social statics, directly intended to disclose the laws of such a connection, in the same way as in all cases of connection between any of the elements of our civilization. The most marked instance of this operation of social science is in the direct study of social dynamics, in virtue of the principle, so familiar to us by this time, that true co-ordination must be disclosed by the natural course of the common development. All scientific men, who have viewed their own particular subject in a large way, have felt what important benefit might be afforded by corresponding historical information, by regulating the spontaneous expansion of scientific discoveries, and warning away from deceptive or premature attempts. I need not set forth the value that there would be in a history of the sciences, which is keenly felt by all who have made any important discovery in any science whatever: but, as my last chapter proves, no real scientific history,—no theory of the true filiation of eminent discoveries, at present exists, in any form or degree. We have only compilations of materials more or less rational, which may be of some provisional use, but which can not be afterward employed in the construction of any historical doctrine without strict revision, and which are certainly, in their present state, unfit to yield any happy scientific suggestions. When a true social science shall have been founded, such labors will assume the philosophical direction of which they are at present destitute, and will aid that development of human genius which now, in the form of unorganized erudition, they merely impede. If we remember that no science can be thoroughly comprehended till its history is understood, we shall see what special improvements this new science must introduce into each of the rest, as well as into the co-ordination of them all.

As to Method.

This leads us to consider the reaction of sociology on the other sciences in regard to Method. Without entering at present upon the great subject of a general theory of the positive method, I must just point out the established truth that each of the fundamental sciences specially manifests one of the chief attributes of the universal positive method, though all are at present, in more or less force, in each science. The special resource of sociology is that it participates directly in the elementary composition of the common ground of our intellectual resources. It is plain that this logical co-operation of the new science is as important as that of any of the anterior sciences. We have seen that sociology adds to our other means of research that which I have called the *historical method*, and which will hereafter, when we are sufficiently habituated to it, constitute a fourth fundamental means of observation. But, though sociology has given us this resource, it is more or less applicable to all orders of scientific speculation. We have only to regard every discovery, at the moment it is effected, as a true social phenomenon, forming a part of the general series of human development, and, on that ground, subject to the laws of succession, and the methods of investigation which characterize that great evolution. From this starting-point, indisputable in its rationality, we comprehend immediately the whole necessary universality of the historical method, thenceforth disclosed in all its eminent intellectual dignity. We can even see that, by this method, scientific discoveries become in a certain degree susceptible of rational prevision, by means of an exact estimate of the anterior movement of the science, interpreted by the laws of the course of the human mind. The historical prevision can hardly become very precise; but it may furnish preparatory indications of the general direction of the contemporary progress, so as to save the vast waste of intellectual forces which is occasioned by conjectural attempts, usually doomed to failure. By this process of comparison of the present with the past, in regard to each science, it must become possible to subject the art of discovery to a kind of rational theory which may guide the instinctive efforts of individual genius, which can not hold its course apart from the general mind, however persuaded it may be of its separation. The historical method will thus, by governing the systematic use of all other scientific methods, impart to them an amplitude of rationality in which they are now deficient, by transferring to the whole that regulated progression which at present belongs only to the details: and the choice of subjects for investigation, till now almost arbitrary, or at least thoroughly empirical, will acquire, in a certain degree, that scientific character which now belongs only to the partial investigation of each of them.—The method itself must, if it is to accomplish these purposes, be subject to the philosophical conditions imposed by the positive spirit of sociology. It must never consider the development of each complete science, separately from the total progression of the human mind, or even from the fundamental evolution of humanity. Thus social physics, which supplies this method, must superintend its gradual application,—at least, in so far as the general conception of human development is concerned. Every partial or isolated use of this method of investigation, such as suits the desultory character of research in our day, would be either wholly ineffectual, or would realize but little good. There are some traces in existing science of this superior means of speculation, the positive method being uniform, and therefore to be found everywhere if anywhere; but its complexity and its recent origin prevent our being able to point to examples at once marked and varied enough to afford a decided manifestation. Throughout the whole range of our positive knowledge, I know of only one unquestionable example; and that will be found, where we should naturally look for it, in mathematical science. We find it in the sublime prefatory chapters of the different sections of the "Analytical Mechanics," so little appreciated by ordinary geometers because they do not contain a single formula, but, in my opinion, proving the eminent philosophical superiority of Lagrange to all mathematicians since Descartes and Leibnitz. By his exposition of the filiation of the chief conceptions of the human mind in regard to rational mechanics, from the origin of the science to our own time, Lagrange certainly anticipated the general spirit of the historical method; because he made this estimate the basis of the whole of his scientific speculations. These remarkable writings are admirable food for meditation not only to geometers, but to all philosophical minds, which may find here the only example of what may properly be called History, though their author made no pretension to the common title of historian.

Thus we see that the reaction of Sociology on the other sciences is as important in a logical as in a scientific view. On the one hand, positive sociology mutually connects all the sciences, and on the other hand, it adds to all resources for investigation, a new and higher method. While, from its nature, dependent on all that went before, Social Physics repays as much as it receives by its two kinds of service toward all other knowledge. We can already perceive that such a science must form the principal band of the scientific sheaf, from its various relations, both of subordination and of direction, to all the rest. It is in this way that the homogeneous co-ordination of real sciences proceeds from their positive development, instead of being derived from any anti-scientific conceptions of a fanciful unity of different phenomena, such as have hitherto been almost exclusively resorted to.

Speculative rank of Sociology.

Social science must always remain inferior in all important speculative respects to all the other fundamental sciences. Yet we can not but feel, after this review of its spirit, its function, and its resources, that the abundance of its means of investigation may establish it in a higher position of rationality than the present state of the human mind might seem to promise. The unity of the subject, notwithstanding its prodigious extent, the conspicuous interconnection of its various aspects, its characteristic advance from the most general to more and more special researches, and finally the more frequent and important use of *à-priori* considerations through suggestions furnished by the anterior sciences, and especially by the biological theory of human nature, may authorize the highest hopes of the speculative dignity of the science,—higher hopes than can be excited by such an imperfect realization as I propose to sketch out, the purpose of which is to embody, in a direct manner, and by sensible manifestations, the more abstract view which I have now taken of the general nature of this new political philosophy, and of the scientific spirit which should regulate its ulterior construction.

CHAPTER V.

SOCIAL STATICS; OR, THEORY OF THE SPONTANEOUS ORDER OF HUMAN SOCIETY.

THOUGH the dynamical part of Social Science is the most interesting, the most easily intelligible, and the fittest to disclose the laws of interconnection, still the Statical part must not be entirely passed over. We must briefly review in this place the conditions and laws of harmony of human society, and complete our statical conceptions, as far as the nascent state of the science allows, when we afterward survey the historical development of humanity.

Three aspects.

Every sociological analysis supposes three classes of considerations, each more complex than the preceding: viz., the conditions of social existence of the individual, the family, and society; the last comprehending, in a scientific sense, the whole of the human species, and chiefly, the whole of the white race.

1. The individual.

Gall's cerebral theory has destroyed for ever the metaphysical fancies of the last century about the origin of Man's social tendencies, which are now proved to be inherent in his nature, and not the result of utilitarian considerations. The true theory has exploded the mistakes through which the false doctrine arose,—the fanciful supposition that intellectual combinations govern the general conduct of human life, and the exaggerated notion of the degree in which wants can create faculties. Independently of the guidance afforded by Gall's theory, there is a conclusive evidence against the utilitarian origin of society in the fact that the utility did not, and could not, manifest itself till after a long preparatory development of the society which it was supposed to have created. We shall the better see how the supposition involves us in a vicious circle if we attend to the character of the early ages of humanity, in which the individual advantages of association are very doubtful, if indeed we may not safely say that, in many cases, the burdens are greater than the resources, as we see only too plainly in the lowest ranks of the most advanced societies. It is thus evident that the social state would never have existed if its rise had depended on a conviction of its individual utility, because the benefit could never have been anticipated by individuals of any degree of ability, but could only manifest itself after the social evolution had proceeded up to a certain point. There are even sophists who at this day deny the utility, without being pronounced mad; and the spontaneous sociability of human nature, independent of all personal calculation, and often in opposi tion to the strongest individual interests, is admitted, as of course, by those who have paid no great attention to the true biological theory of our intellectual and moral nature.

Passing over some elementary considerations which belong rather to a special treatise on the physiological conditions,—such as the natural nakedness of the human being, and his helpless and protracted infancy,—which have been much exaggerated as social influences, since they exist in some animal races without producing the same social consequences—I proceed to estimate the influence of the most important attributes of our nature in giving to society the fundamental character which belongs to it, and which remains permanent through all degrees of its development. In this view, the first consideration is of the preponderance of the affective over the intellectual faculties, which, though less remarkable in Man than in other animals, yet fixes the first essential idea of our true nature.—Though continuous action is, in all cases, an indispensable condition of success, Man, like every other animal, has a natural dislike to such perseverance, and at first finds pleasure only in a varied exercise of his activity,—the variety being of more importance to him than moderation in degree,—especially in the commonest cases, in which no strongly-marked instinct is concerned. The intellectual faculties being naturally the least energetic, their activity, if ever so little protracted beyond a certain degree, occasions in most men a fatigue which soon becomes utterly insupportable; and it is in regard to them chiefly that men of all ages of civilization relish that state of which the *dolce far niente* is the most perfect expression. Nevertheless, it is on the persevering use of these high faculties that the modifications of human life, general and individual, depend, during the course of our social development, so that we are met at once by the melancholy coincidence that Man is most in need of precisely the kind of activity for which he is the least fit. His physical imperfections and moral necessities compel him, more than any other animal, to employ his reason in amending his primitive condition; while his reason is so far from being adequate to its work that it is subject to an irresistible fatigue which can be moderated only by strong and constant stimulus. Instead of lamenting over this discordance, we must receive it as a first authentic information supplied to social science by biology, and one which must radically affect the general character of human society first, and afterward the rate of the social evolution. The consequence which immediately concerns us here is, that almost all men are naturally unfit for intellectual labor, and devoted to material activity; so that the speculative state can not well be produced, much less sustained, in them but by some impulse of another kind, kept up by lower but stronger propensities. However important individual differences in this respect may be, the differences are of degree only, so that the most eminent natures hold their place in the comparison; and men must be classed, in a scientific sense, by the nobleness or increasing speciality of the affective faculties by which the intellectual incitement is produced. If we observe the ascending scale of these faculties, upon Gall's theory, we see that, among the generality of men, the intellectual tension is (with some exceptions of that speculative impulse to which all human beings are liable) habitually supported only by the strong stimulus derived from the needs of the organic life, and the commonest instincts of the animal life, the organs of which lie at the back of the brain. The individual nature of man becomes lofty in proportion as the incitement proceeds from propensities which are of a higher order, more peculiar to our species, and placed, anatomically, further forward in the brain, while yet the activity of the intellectual region can never, in the noblest cases, be independent of such stimulus, unless the habit of meditation has actually become preponderant, —a case too rare to be considered in a general view.—Lest we should form a false philosophical estimate of our case, I may observe that, however we may regret the degree in which our intellectual faculties are less active than the lower, we must beware of wishing that the case was reversed. If our affective faculties were subordinated to the intellectual, all idea of improving the social organism would be merely senseless. It would be like polishing our roads, instead of merely diminishing their friction, which would not improve the accustomed locomotion, but render its mechanism contradictory to the fundamental laws of motion. For our affective faculties must preponderate, not only to rouse our reason from its natural lethargy, but to give a permanent aim and direction to its activity, without which it would be for ever lost in a vague abstract speculation. Even under our actual conditions, which subject the wildest reveries to more or less control of reality, we see how the most mystical efforts of pious ecstasy to conceive of an ideal state, exempt from organic wants and from all human passions, have issued, even in the highest minds, in conceptions of a sort of transcendental idiotcy, eternally absorbed in a foolish and almost stupid contemplation of the divine majesty. Our social organism is, then, what it ought to be, except as to degree; and we must observe and remember that it is in our power, within certain narrow limits, to rectify this degree of difference; or rather, that the rectification takes place in proportion to the steady development of civilization, which tends to subordinate our propensities to our reason, more and more, without giving us any cause to apprehend a reversal of the order at any future time.

The second consideration is that, besides the preponderance of the affective over the intellectual life, the lowest and most personal propensities have, in regard to social relations, an unquestionable preponderance over the nobler. According to the sound biological theory of man, our social affections are inferior in strength and steadiness to the personal, though the common welfare must depend especially on the regular satisfaction of the former, which first originate the social state for us, and then maintain it against the divergences of individual instincts. To understand the sociological value of this biological datum, we must observe, as in the former case, that the condition is necessary, and that it is only its degree that we have to deplore. In analogy with the former case, personal instincts must give an aim and direction to our social action. All notions of public good must be based upon those of private advantage, because the former can be nothing else than that which is common to all cases of the latter: and under no ideal refinement of our nature could we ever habitually desire for others anything else but what we wish for ourselves,—unless in those infinitely rare and very secondary cases in which an excessive refinement of moral delicacy, fostered by intellectual meditation, may enable a man to appreciate for another means of happiness which are of little or no value to himself. Our moral nature would then be destroyed, and not improved, if it were possible to repress our personal instincts, since our social affections, deprived of necessary direction, would degenerate into a vague and useless charity, destitute of all practical efficacy. When the morality of an advanced society bids us love our neighbors as ourselves, it embodies in the best way the deepest truth, with only such exaggeration as is required in the formation of a type, which is always fallen short of in practice. In this sublime precept, the personal instinct is the guide and measure of the social; and in no other way could the principle be presented; for in what respect, and how, could any one love another who did not love himself? Thus, again, we may be satisfied with the nature of Man, though not with the degree of his self-regards. We must regret that even in the best natures, the social affections are so overborne by the personal, as rarely to command conduct, in a direct way. In this sense, we may conceive, after a comparison of the two cases I have presented, that the sympathetic instinct and the intellectual activity are especially destined to compensate mutually their common social insufficiency. We may say, indeed, that if Man became more benevolent, that would be equivalent in social practice to his being more intelligent, not only because he would put his actual intelligence to better use, but because it would not be so much absorbed by the discipline which it must be constantly imposing on the strong preponderance of the personal propensities. But the converse supposition is not less exact, though it is less appreciable; for all real intellectual development is finally equivalent, in regard to the conduct of life, to a direct augmentation of natural benevolence, both by strengthening Man's empire over his passions, and by refining the habitual sense of the reactions occasioned by various social contact. If we admit, in the first case, that no great intellect can duly expand without a certain amount of universal benevolence, by which alone it can have free impulse, a lofty aim, and large exercise; so, inversely, we can not doubt that all noble intellectual expansion fortifies general sympathy, not only by casting out selfish instigations, but by inspiring a wise predilection in favor of social order, which may, notwithstanding its ordinary coldness, concur as fortunately in the maintenance of social harmony as dispositions which are more lively and less steady. The reciprocal connection of those two chief moderators of human life, intellectual activity and the social instinct, seems thus to be unquestionable: and the first function of universal morals, in regard to the individual, consists in increasing this double influence, the gradual extension of which constitutes the first spontaneous result of the general development of humanity. And the double opposition between Man's moral and material need of intellectual toil and his dislike of it, and again, between Man's need, for his own happiness, of the social affections, and the necessary subjection of these to his personal instincts, discloses the scientific germ of the struggle which we shall have to review, between the conservative and the reforming spirit; the first of which is animated by purely personal instincts, and the other by the spontaneous combination of intellectual activity with the various social instincts.

So much for the first statical division—the Individual. Next, we must consider the Family.

2. The Family.

As every system must be composed of elements of the same nature with itself, the scientific spirit forbids us to regard society as composed of individuals. The true social unit is certainly the family—reduced, if necessary, to the elementary couple which forms its basis. This consideration implies more than the physiological truth that families become tribes, and tribes become nations: so that the whole human race might be conceived of as the gradual development of a single family, if local diversities did not forbid such a supposition. There is a political point of view from which also we must consider this elementary idea, inasmuch as the family presents the true germ of the various characteristics of the social organism. Such a conception is intermediate between the idea of the individual and that of the species, or society. There would be as many scientific inconveniences in passing it over in a speculative sense as there are dangers in practice in pretending to treat of social life without the inevitable preparation of the domestic life. Whichever way we look at it, this necessary transition always presents itself, whether in regard to elementary notions of fundamental harmony, or for the spontaneous rise of social sentiment. It is by this avenue that Man comes forth from his mere personality, and learns to live in another, while obeying his most powerful instincts. No other association can be so intimate as this primary combination, which causes a complete fusion of two natures in one. Owing to the radical imperfection of the human character, individual divergences are too marked to admit of so close an association in any other case. The common experience of human life teaches us only too well that men must not live too familiarly together, if they are to bear, in mutual peace, the infirmities of our nature—whether of the intellect or the affections. Even religious communities, united as they are by a special bond, were, as we know, perpetually tormented by internal dissensions, such as it is impossible to avoid if we attempt to reconcile qualities so incompatible as the intimacy and the extension of human relations. Even in the family, the intimacy is owing to the strong spontaneousness of the common end, combined with the equally natural institution of an indispensable subordination. Whatever talk there may be, in modern times, of social equality, even the most restricted society supposes, not only diversities, but inequalities; for there can be no association without a permanent concurrence in a general operation, pursued by distinct means, mutually subordinated. Now, the most entire realization possible of these elementary conditions is inherent in the family alone, where nature has supplied all the requisites of the institution. Thus, notwithstanding the temporary abuse of the family spirit in the way of excess, which has occasionally brought reproach on the institution, it is, and will ever be, the basis of the social spirit, through all the gradual modifications which it may have to undergo in the course of the human evolution. The serious assaults upon this institution which we witness in our day must, therefore, be regarded as the most alarming symptoms of our temporary tendency to social disorganization. But such a direction of the revolutionary spirit is a dangerous symptom only on account of the decrepitude of the belief on which the idea of the Family, like every other social idea, is made to rest. As long as the family relation has no other intellectual basis than religious doctrine, it will share whatever discredit belongs to that doctrine in the present state of human development. The Positive philosophy, which reorganizes whatever it touches, can alone re-establish the conception on an immutable foundation, by transferring all social speculation from the region of vague ideality to the ground of indisputable reality.

The constitution of the human family has undergone modifications of a progressive kind which appear to me to disclose, at each epoch of development, the exact importance of the change wrought in the corresponding social state. Thus, the polygamy of less-advanced nations must give a character to the family wholly different from that which it has among nations which are capable of that monogamy to which our nature tends. In the same way, the ancient family, which consisted partly of slaves, must be very unlike the modern, which is mainly reduced to the kindred of the couple, and in which the authority of the head is comparatively small. But the estimate of these modifications will find its right place in my historical review. Our object now is to consider the elementary scientific aspect of the family; that aspect which is made common to all social cases by regarding the domestic as the basis of all social life. In this view, the sociological theory of the family is reducible to the investigation of two orders of relations, viz., the subordination of the sexes, which institutes the family, and that of ages, which maintains it. A certain amount of voluntary association takes place from that degree of the biological scale at which sex begins; and it is always occasioned by the sexual union first, and then by the rearing of progeny. If the sociological comparison must stop at the two great classes of superior animals, birds and mammifers, it is because none below them present a sufficiently complete realization of this double elementary character.

The sexual relation.

We can not too reverently admire that universal natural disposition, on which all association is grounded, by which, in the state of marriage, however imperfect, the strongest instinct of our animal nature, at once satisfied and disciplined, occasions harmony instead of the disorder which would arise from its license. It was not to be expected that, when the revolutionary spirit was attacking everything else, it should allow marriage to escape—connected as it has hitherto been with the theological philosophy. When the positive philosophy shall have established the subordination of the sexes, and in that, the principle of marriage and of the family, it will take its stand on an exact knowledge of human nature, followed by an appreciation of social development as a whole, and of the general phase which it now presents; and in doing this it will extinguish the fancies by which the institution is at present discredited and betrayed. No doubt Marriage, like every other human concern, undergoes modifications as human development proceeds. Modern marriage, as constituted by Catholicism, is radically different, in various respects, from Roman marriage, as that differed from the Greek, and both, in a much greater degree, from the Egyptian or Oriental, even after the establishment of monogamy. It is undisputed that these modifications have not come to any end, and that the great social reconstitution for which we are looking will establish the general character of the association, which all preceding modifications have progressively developed. Meantime, the absolute spirit of the existing political philosophy mistakes such modifications for an overthrow of the institution; a state of things very analogous to that of the ancient times, when the Greek philosophy was about to make way for the Christian regeneration of the family and of society, and when fantastical errors, caused by the long intellectual interregnum, gave occasion to the famous satire of Aristophanes, which we may accept as a rude rebuke of our own licentiousness.

What the ultimate conditions of marriage will be, we can not know as yet; and if we could, this is not the place to treat of them. It is enough for our purposes to be assured that they will be consonant with the fundamental principle of the institution,—the natural subordination of the woman, which has reappeared under all forms of marriage, in all ages, and which the new philosophy will place on its right basis,—a knowledge of the individual organism first, and then of the social organism. Biological philosophy teaches us that, through the whole animal scale, and while the specific type is preserved, radical differences, physical and moral, distinguish the sexes. Comparing sex with age, biological analysis presents the female sex, in the human species especially, as constitutionally in a state of perpetual infancy, in comparison with the other; and therefore more remote, in all important respects, from the ideal type of the race. Sociology will prove that the equality of the sexes, of which so much is said, is incompatible with all social existence, by showing that each sex has special and permanent functions which it must fulfil in the natural economy of the human family, and which concur in a common end by different ways, the welfare which results being in no degree injured by the necessary subordination, since the happiness of every being depends on the wise development of its proper nature.

We have seen that the preponderance of the affective faculties is less marked in Man than in the lower animals, and that a certain degree of spontaneous speculative activity is the chief cerebral attribute of humanity, as well as the prime source of the marked character of our social organism. Now, the relative inferiority of Woman in this view, is incontestable, unfit as she is, in comparison, for the requisite continuousness and intensity of mental labor, either from the intrinsic weakness of her reason or from her more lively moral and physical sensibility, which are hostile to scientific abstraction and concentration. This indubitable organic inferiority of feminine genius has been confirmed by decisive experiment, even in the fine arts, and amidst the concurrence of the most favorable circumstances. As for any functions of government, the radical inaptitude of the female sex is there yet more marked, even in regard to the most elementary state, and limited to the guidance of the mere family, the nature of the task requiring, above everything, an indefatigable attention to an aggregate of complex relations, none of which must be neglected, while the mind must be independent of the passions; in short, reasonable. Thus, the economy of the human family could never be inverted without an entire change in our cerebral organism, and the only possible result of a resistance to natural laws would be to deprive Woman of the enjoyment of her proper welfare by disturbing the family and society. Again, we have seen that, in the affective life of Man, the personal instincts overrule the sympathetic or social, which last can, and do, only modify the direction decided by the first, without becoming the habitual moving powers of practical existence. Here again, by a comparative examination, we can estimate the happy social position appropriated to the female sex. It is indisputable that women are, in general, as superior to men in a spontaneous expansion of sympathy and sociality, as they are inferior to men in understanding and reason. Their function in the economy of the family, and consequently of society, must therefore be to modify by the excitement of the social instinct the general direction necessarily originated by the cold and rough reason which is distinctive of Man. Apart from all consideration of material differences, and contemplating exclusively the noblest properties of our cerebral nature, we see that, of the two attributes which separate the human race from the brutes, the primary one indicates the necessary and invariable preponderance of the male sex, while the other points out the modera ting function which is appropriate to Woman, even independently of maternal cares, which evidently constitute her most important special destination, but which are usually too exclusively insisted on, so as to disguise the direct social and personal vocation of the female sex.

The Parental relation.

The other great element of the human family is the relation between parents and children, which spread abroad through the whole of society, produces the natural subordination of ages. The discipline prescribed by nature in this relation is too unquestionable to admit of the same attacks of the revolutionary spirit which have been directed toward the preceding relation. The ardent champions of the political rights of women have not yet offered an analogous doctrine in regard to children, who are less able to stimulate the zeal of their special champions. Wild as are the eccentricities of our social anarchy, popular good sense, however imperfect it may still be, imposes some restraint on individual absurdities when they go so far as to shock a primary instinct.

There is certainly no natural economy more worthy of admiration than that spontaneous subordination which, first constituting the human family, then becomes the type of all wise social co-ordination. The testimony of ages has done honor to this type; and when Man has formed his conception of providential government on the most perfect direction of events that he could conceive, he has taken this institution for his model. There is no other case which offers, in the same degree, the most respectful spontaneous obedience, on the part of the inferior, without the least degradation; an obedience imposed by necessity first, and then by gratitude; and nowhere else do we see in the superior party the most absolute authority united to entire devotedness, too natural and too genial to be regarded as duty. These characteristics must become weakened in the case of wider and less intimate relations; the submission can not be so complete and spontaneous, nor the protection so affectionate and devoted. But family life will, nevertheless, be eternally the school of social life, both for obedience and for command, which will be excellent in proportion to their approach to this model; and in the future, as in the past, the modifications of society will correspond with those which human progression must occasion in the domestic constitution. In all critical periods, however, there have been false reasoners who have argued from the inconveniences which attend this institution, like every other, against the organization itself, and who would mend it by means of a total inversion,—proposing to make society the model of the family; at a time, too, when society is in no condition to serve as a type for any kind of orderly arrangement. All domestic discipline would be impossible under a system which would take from parents the guidance and almost the acquaintance of their children, through a monstrous exaggeration of the influence of society on the education of youth; and children, of the hereditary transmission of their parents' prop erty, accumulated on their behalf,—obedience and authority being thus successively destroyed. This work is not the place in which to examine such extravagances; but it was necessary to refer to this particular delusion in order to show the fitness of the positive polity to consolidate all the primary ideas of social order, amidst the confusion attending the decline of the theological philosophy. Here, as everywhere else, we shall find the positive philosophy subordinating all schemes of artificial order to the observation of natural order: and we shall perceive that the modifications wrought out by the social evolution are superior to any that the most eminent reformers would have ventured to conceive of beforehand,—a fact which should teach us not to interfere with the succession of different portions of the reorganization by attempting to renovate everything at once, down to the smallest details, according to the routine of modern constitutions.

We must not omit the striking property of domestic organization,—that it establishes the elementary idea of social perpetuity, by directly and irresistibly connecting the future with the past. When duly generalized, the idea and the feeling pass on from the immediate parents to ancestors, and issue in that universal respect for our predecessors which is an indispensable condition of all social economy. There is no social state which does not present evidences of it. The diminishing influence of traditions as human development proceeds, and the growing preference of written to oral transmission, must modify the expression of the sentiment among the moderns, if not the sentiment itself; but whatever point social progression may attain, it will always be supremely important that Man should not regard himself as a being of yesterday, and that the whole of his institutions and customs should connect, by a system of intellectual and material tokens, his remembrances of the entire past with his hopes for the future. The tendency of the revolutionary philosophy is to foster a disdain of the past, on account of its politics; and I need not add that the positive philosophy, which takes history for its scientific basis, which represents all the men of all times as co-operating in the same evolution, and which perseveringly connects all existing progress with the whole of antecedent human action, is thoroughly adapted to confirm the idea and sentiment of social continuity. In fact, we see that the region of the positive sciences is the only one in which this reverent co-ordination of the present with the past, has withstood the encroachments of the revolutionary philosophy, which, in every other connection, would almost have us believe that reason and justice are creations of our own day.

It is not necessary to enlarge here on the fraternal relation, though it would obtain its share of attention if we were engaged in forming a constitution of society. For our purposes here, the brotherly relation offers little subject of remark, interesting as it is from the sweetness or the bitterness which it sheds over private life. If the brothers are nearly of the same age, there is little subordination in the case: and if the difference in age is sufficient to admit of that subordination, the relation becomes, for analytical purposes, like that of parent and child. All that it is in our way to remark here is that true social science will never fail, either in studying the past, or speculating on the future, to assign the rank of absolute requisites to all elements which have, through all time, constituted an essential part of the domestic hierarchy. Discarding all Utopian fancies, and proposing to observe the economy of real society, we must bring into our scientific analysis all the arrangements which, by their steady permanence, indicate their grave importance.

The third head of our statical analysis brings us to the consideration of society, as composed of families and not of individuals, and from a point of view which commands all times and places.

3. Society. The main cause of the superiority of the social to the individual organism is, according to an established law, the more marked speciality of the various functions fulfilled by organs more and more distinct, but interconnected; so that unity of aim is more and more combined with diversity of means. We can not, of course, fully appreciate a phenomenon which is for ever proceeding before our eyes, and in which we bear a part; but if we withdraw ourselves in thought from the social system, and contemplate it as from afar, can we conceive of a more marvellous spectacle, in the whole range of natural phenomena, than the regular and constant convergence of an innumerable multitude of human beings, each possessing a distinct and, in a certain degree, independent existence, and yet incessantly disposed, amidst all their discordance of talent and character, to concur in many ways in the same general development, without concert, and even consciousness on the part of most of them, who believe that they are merely following their personal impulses? This is the scientific picture of the phenomenon: and no temporary disturbances can prevent its being, under all circumstances, essentially true. This reconciliation of the individuality of labor with co-operation of endeavors, which becomes more remarkable as society grows more complex and extended, constitutes the radical character of human operations when we rise from the domestic to the social point of view. The degree of association that we observe among the superior animals, has something voluntary in it, but there is no organization which can make it resemble the human: and the first individual specializing of common functions is seen in our simple domestic life, which is thus a type of the social organization. The division of labor can never, however, be very marked in the family, because the members are few; and yet more because such a division would soon show itself to be hostile to the spirit of the institution; for domestic training, being founded on imitation, must dispose the children to follow parental employments, instead of undertaking new ones: and again, any very marked separation in the employments of the members must impair the domestic unity which is the aim of the

association. The more we look into the subject, the more we shall see that the appropriation of employments, which is the elementary principle of general society, can not hold anything like so important a place in the family. In fact, the domestic relations do not constitute an association, but a *union*, in the full force of the term; and, on account of this close intimacy, the domestic connection is of a totally different nature from the social. Its character is essentially moral, and only incidentally intellectual; or, in anatomical language, it corresponds more to the middle than to the anterior part of the brain. Founded chiefly upon attachment and gratitude, the domestic union satisfies, by its mere existence, all our sympathetic instincts, quite apart from all idea of active and continuous co-operation toward any end, unless it be that of its own institution. Though more or less co-ordination of different employments must exist, it is so secondary an affair that when, unhappily, it remains the only principle of connection, the domestic union degenerates into mere association, and is even too likely to dissolve altogether. In society the elementary economy presents an inverse character, the sentiment of co-operation becoming preponderant, and the sympathetic instinct, without losing its steadiness, becoming secondary. No doubt there are a multitude of men well enough organized to love their fellow-laborers, however numerous or remote they may be, and however indirect may be their co-operation; but such a sentiment, arising from the reaction of the reason upon the social feelings, could never be strong enough to guide social life. Even under the best circumstances the intellectual mediocrity of the majority of men does not allow them to form any distinct idea of relations which are too extensive, too indirect, and too foreign to their own occupations, to impart any sympathetic stimulus which could be of permanent use. It is only in domestic life that Man can habitually seek the full and free expansion of his social affections; and perhaps this is the chief reason why it is the last indispensable preparation for social life; for concentration is as necessary to the feelings as generalization to the thoughts. Even the most eminent men, who direct their sympathetic instincts upon their race at large, or the society in which they live, are usually impelled to this by the moral disappointments of a domestic life which has failed in some of its conditions; and however genial the imperfect compensation may be to them, this abstract love of their species admits of nothing like that satisfaction of the affections which arises from a very limited, and especially an individual attachment. However this may be, such cases are beside too evidently exceptional to affect any inquiry into the social economy. Thus, though the sympathetic instinct exists wherever there is association, more or less, the principle of co-operation is that which must prevail, when we pass on from the consideration of the family to the general co-ordination of families. To attribute to it the formation of the social state, as it was the fashion of the last century to do, is a capital error; but, when the association has once begun, there is nothing like this principle of co-operation for giving consistency and character to the combination. In the lower stages of savage life we see families combining for a temporary purpose, and then returning, almost like the brutes, to their isolated independence, as soon as the expedition, which is usually one of war or the chase, is ended, though already some common opinions, expressed in a certain uniform language, are preparing them for permanent union in tribes, more or less numerous. It is upon the principle of co-operation, then, spontaneous or concerted, that we must found our analysis of the last division of social statics.

Distribution of employments.

We must include in our view of the division of employments something much more extensive than the material arrangements which the expression is usually understood to convey. We must include under it all human operations whatever, regarding not only individuals and classes, but also, in many ways, different nations, as participating, in a special mode and degree, in a vast common work, the gradual development of which connects the fellow-laborers with the whole series of their predecessors, and even with their successors. This is what is meant when we speak of the race being bound up together by the very distribution of their occupations; and it is this distribution which causes the extent and growing complexity of the social organism, which thus appears as comprising the whole of the human race. Man can hardly exist in a solitary state: the family can exist in isolation, because it can divide its employments and provide for its wants in a rough kind of way: a spontaneous approximation of families is incessantly exposed to temporary rupture, occasioned by the most trifling incidents. But when a regular division of employments has spread through any society, the social state begins to acquire a consistency and stability which place it out of danger from particular divergencies. The habit of partial co-operation convinces each family of its close dependence on the rest, and, at the same time, of its own importance, each one being then justified in regarding itself as fulfilling a real public function, more or less indispensable to the general economy, but inseparable from the system as a whole. In this view the social organization tends more and more to rest on an exact estimate of individual diversities, by so distributing employments as to appoint each one to the destination he is most fit for, from his own nature (which however is seldom very distinctly marked), from his education and his position, and, in short, from all his qualifications; so that all individual organizations, even the most vicious and imperfect (short of monstrosity), may be finally made use of for the general good. Such is, at least, the social type which we conceive of as the limit of the existing social order, and to which we may be for ever approximating, though without the hope of ever attaining it; and it is, in fact, a reproduction, with a large extension, of the domestic organism, with less power, in proportion to its extent, of appointing a due destination to every member; so that the social discipline must always be more artificial, and therefore more imperfect, than the domestic, which Nature herself ordains and administers.

The necessities of this co-operation and distribution of special offices cause inconveniences which I am compelled to advert to; for it is in the investigation of these that we find the scientific germ of the relation between the idea of society and that of government.

Inconveniences.

Some economists have pointed out, but in a very inadequate way, the evils of an exaggerated division of material labor; and I have indicated, in regard to the more important field of scientific labor, the mischievous intellectual consequences of the spirit of speciality which at present prevails. It is necessary to estimate directly the principle of such an influence, in order to understand the object of the spontaneous system of requisites for the continuous preservation of society. In decomposing, we always disperse; and the distribution of human labors must occasion individual divergencies, both intellectual and moral, which require a permanent discipline to keep them within bounds. If the separation of social functions develops a useful spirit of detail on the one hand, it tends, on the other, to extinguish or to restrict what we may call the aggregate or general spirit. In the same way, in moral relations, while each individual is in close dependence on the mass, he is drawn away from it by the expansion of his special activity, constantly recalling him to his private interest, which he but very dimly perceives to be related to the public. On both grounds the inconveniences of the division of functions increase with its characteristic advantages, without their being in the same relation, throughout the spontaneous course of the social evolution. The growing speciality of habitual ideas and familiar relations must tend to restrict the understanding more and more, while sharpening it in a certain direction, and to sever more and more the private interest from a public interest which is for ever becoming more vague and indirect; while, at the same time, the social affections, gradually concentrated among individuals of the same profession, become more and more alienated from all other classes, for want of a sufficient analogy of ways and ideas. Thus it is that the principle by which alone general society could be developed and extended, threatens, in another view, to decompose it into a multitude of unconnected corporations, which almost seem not to belong to the same species; and hence it is that the gradual expansion of human ability seems destined to produce such minds as are very common among civilized peoples, and prodigiously admired by them,—minds which are very able in some one respect and monstrously incapable in all others. If we have been accustomed to deplore the spectacle, among the artisan class, of a workman occupied during his whole life in nothing else but making knife-handles or pins'-heads, we may find something quite as lamentable in the intellectual class, in the exclusive employment of a human brain in resolving some equations, or in classifying insects.

The moral effect is, unhappily, analogous in the two cases. It occasions a miserable indifference about the general course of human affairs, as long as there are equations to resolve and pins to manufacture. This is an extreme case of human automatism; but the frequency, and the growing frequency, of the evil gives a real scientific importance to the case, as indicating the general tendency, and warning us to restrain it. Thus it appears to me that the social destination of government is to guard against and restrain the fundamental dispersion of ideas, sentiments, and interests, which is the inevitable result of the very principle of human development, and which, if left to itself, would put a stop to social progression in all important respects.

Basis of the true theory of government.

Here we have, in my opinion, the basis of the elementary and abstract theory of government, regarded in its complete scientific extension; that is, as characterized by the universal necessary reaction—first spontaneous and then regulated—of the whole upon the parts. It is clear that the only way of preventing such a dispersion is by setting up this reaction as a new special function, which shall intervene in the performance of all the various functions of the social economy, to keep up the idea of the whole, and the feeling of the common interconnection; and the more energetically, the more individual activity tends to dissolve them. Not itself effecting any determinate social progress, it contributes to all that society can achieve, in any direction whatever, and which society could not achieve without its concentrating and protective care. The very nature of its action indicates that it can not be merely material, but also, and much more, intellectual and moral; so as to show the double necessity of what has been called the temporal and spiritual government, the rational subordination of which was the best feature of the social organization that was happily effected in its day, under the influence of the prevalent Catholicism. Moreover, this ruling function must become more, instead of less necessary, as human development proceeds, because its essential principle is inseparable from that of the development itself.—Thus, it is the habitual predominance of the spirit of the whole which constitutes government, in whatever way it is regarded. The next consideration is, how such an action arises, independently of all systematic combination, in the natural course of the social economy.

Elementary subordination.

If the dispersive tendency arising from the distribution of functions naturally propagates itself, it is clear that any influence capable of neutralizing it must also be constantly expanding. In fact, an elementary subordination must always be growing out of the distribution of human operations, which gives birth to government, in the bosom of society itself, as we could easily discover by analyzing any marked subdivision which has just taken place in any employment whatever. This subordination is not only material, but yet more intellectual and moral; that is, it requires, besides practical submission, a corresponding degree of real confidence in both the capacity and the probity of the special organs to whom a function, hitherto universal, is confided. Every one of us relies, even for life itself, on the aptitude and the morality of a multitude of almost unknown agents, whose folly or wickedness might affect the welfare of vast numbers of human beings. Such a condition belongs to all modes of social existence. If it is especially attributed to industrial societies, it is only because it must be most conspicuous where the division of labor goes furthest; and it is as certainly to be found in purely military societies; as the statical analysis of an army, a man-of-war, or any other active corporation shows in a moment.

This elementary subordination discloses its own law; which is, that the various operations in which individuals are engaged fall naturally under the direction of those which are next above them in generality. We may easily convince ourselves of this by analyzing any special occupation at the moment when it assumes a separate character: because the task thus separated is necessarily more special than the function from which it proceeds, and to which its own fulfilment must be subordinated. This is not the occasion on which to expatiate on this law; but its political bearing concerns us here,—indicating as it does the germ of a true classification of social functions. We shall hereafter meet with a full verification of this law in regard to the industrial life of modern societies: the eminent regularity of military associations renders the law obvious at once; and when the law is once admitted, it discloses the spontaneous connection of this elementary social subordination with that political subordination, properly so called, which is the basis of government, and which presents itself as the last degree in the hierarchy formed by the subjection of the more special to the more general classes of phenomena. For, as the various particular functions of the social economy are naturally implicated in relations of greater generality, all must at length be subject to the direction of the most general function of all, which is characterized, as we have seen, by the constant action of the whole upon the parts. On the other hand, the organs of this direction must be much strengthened by the encouragement afforded to intellectual and moral inequality under a system of division of employments. It is clear that while men were obliged to do everything for themselves, they must have been confined to domestic life, devoting all their activity to supply the wants of the family; and there could be little expansion of individual ability and character. Though marked individuality must always have made itself felt, in every state of society, the division of labor, and the leisure which it brings, have been needful to the conspicuous development of that intellectual superiority on which all political ascendency must mainly rest. We must observe, moreover, that there can be no such division of intellectual as of material labor; so that the intellectual functions must be less affected than the industrial by the dispersive tendencies of such a division. We are familiar with the effect of civilization in developing moral, and yet more, intellectual inequalities; but we must bear in mind that moral and intellectual forces do not admit, like the physical, of being accumulated and compounded: so that, eminently as they can concur and clearly as they are the creators of social concurrence, they are much less adapted for direct co-operation. A sufficient coalition of the most insignificant individuals can easily carry any point of physical conflict, or of acquisition of wealth, against the highest superiority in an individual or a family; so that, for example, the most enormous private fortune can not sustain any competition with the financial power of a nation, whose treasury is filled by a multitude of the smallest contributions. But, on the contrary, if the enterprise depends on a high intellectual power, as in the case of a great scientific or poetical conception, there can be no association of ordinary minds, however extensive, which can compete with a Descartes or a Shakspere. It is the same in the moral case; as, for instance, if society is in need of any great resource of devotedness, the want can not be supplied by accumulating any amount of moderate zeal furnished by individuals. The only use of a multitude in such a case is that it improves the chance of finding the *unique* organ of the proposed function; and when that singular agent is once found, there is no degree of multitude which can weigh down its preponderance. It is through this privilege that intellectual and moral forces tend to an ever-increasing social authority, from the time when a due division of employments admits of their proper development.

Tendency of society to government.

Such is, then, the elementary tendency of all human society to a spontaneous government. This tendency accords with a corresponding system, inherent in us as individuals, of special dispositions toward command in some, and toward obedience in others. We must not, with regard to the first, confound the desire to rule with the fitness to do so; though the desire is one element of the fitness: and, on the other hand, there is a much stronger inclination to obedience in the generality of men than it is customary in our day to suppose. If men were as rebellious as they are at present represented, it would be difficult to understand how they could ever have been disciplined: and it is certain that we are all more or less disposed to respect any superiority, especially any intellectual or moral elevation, in our neighbors, independently of any view to our own advantage: and this instinct of submission is, in truth, only too often lavished on deceptive appearances. However excessive the desire of command may be in our revolutionary day, there can be no one who, in his secret mind, has not often felt, more or less vividly, how sweet it is to obey when he can have the rare privilege of consigning the burdensome responsibility of his general self-conduct to wise and trustworthy guidance: and probably the sense of this is strongest in those who are best fitted for command. In the midst of political convulsion, when the spirit of revolutionary destruction is abroad the mass of the people manifest a scrupulous obedience toward the intellectual and moral guides from whom they accept direction, and upon whom they may even press a temporary dictatorship, in their primary and urgent need of a preponderant authority. Thus do individual dispositions show themselves to be in harmony with the course of social relations as a whole, in teaching us that political subordination is as inevitable, generally speaking, as it is indispensable. And this completes the elementary delineation of Social Statics.

My sketch has perhaps been so abstract and condensed that the conceptions of this chapter may appear obscure at present; but light will fall upon them as we proceed. We may already see, however, the practical advantage which arises from the scientific evolution of human relations. The individual life, ruled by personal instincts; the domestic, by sympathetic instincts; and the social, by the special development of intellectual influences, prepare for the states of human existence which are to follow: and that which ensues is, first, personal morality, which subjects the preservation of the individual to a wise discipline; next, domestic morality, which subordinates selfishness to sympathy; and lastly, social morality, which directs all individual tendencies by enlightened reason, always having the general economy in view, so as to bring into concurrence all the faculties of human nature, according to their appropriate laws.

CHAPTER VI.

SOCIAL DYNAMICS; OR, THEORY OF THE NATURAL PROGRESS OF HUMAN SOCIETY.

Scientific view of human progression.

If we regard the course of human development from the highest scientific point of view, we shall perceive that it consists in educing, more and more, the characteristic faculties of humanity, in comparison with those of animality; and especially with those which Man has in common with the whole organic kingdom. It is in this philosophical sense that the most eminent civilization must be pronounced to be fully accordant with nature, since it is, in fact, only a more marked manifestation of the chief properties of our species; properties which, latent at first, can come into play only in that advanced state of social life for which they are exclusively destined. The whole system of biological philosophy indicates the natural progression. We have seen how, in the brute kingdom, the superiority of each race is determined by the degree of preponderance of the animal life over the organic. In like manner, we see that our social evolution is only the final term of a progression which has continued from the simplest vegetables and most insignificant animals, up through the higher reptiles, to the birds and the mammifers, and still on to the carnivorous animals and monkeys, the organic characteristics retiring, and the animal prevailing more and more, till the intellectual and moral tend toward the ascendency which can never be fully obtained, even in the highest state of human perfection that we can conceive of. This comparative estimate affords us the scientific view of human progression, connected, as we see it is, with the whole course of animal advancement, of which it is itself the highest degree. The analysis of our social progress proves indeed that, while the radical dispositions of our nature are necessarily invariable, the highest of them are in a continuous state of relative development, by which they rise to be preponderant powers of human existence, though the inversion of the primitive economy can never be absolutely complete. We have seen that this is the essential character of the social organism in a statical view: but it becomes much more marked when we study its variations in their gradual succession.

Course of Man's social development.

Civilization develops, to an enormous degree, the action of Man upon his environment: and thus, it may seem, at first, to concentrate our attention upon the cares of material existence, the support and improvement of which appear to be the chief object of most social occupations. A closer examination will show, however, that this development gives the advantage to the highest human faculties, both by the security which sets free our attention from physical wants, and by the direct and steady excitement which it administers to the intellectual functions, and even the social feelings. In Man's social infancy, the instincts of subsistence are so preponderant, that the sexual instinct itself, notwithstanding its primitive strength, is at first controlled by them: the domestic affections are then much less pronounced; and the social affections are restricted to an almost imperceptible fraction of humanity, beyond which everything is foreign, and even hostile: and the malignant passions are certainly, next to the animal appetites, the mainspring of human existence. It is unquestionable that civilization leads us on to a further and further development of our noblest dispositions and our most generous feelings, which are the only possible basis of human association, and which receive, by means of that association, a more and more special culture. As for the intellectual faculties,—we see, by the habitual improvidence which characterizes savage life, how little influence reason has over men in that stage of existence. Those faculties are then undeveloped, or show some activity only in the lowest order, which relate to the exercise of the senses: the faculties of abstraction and combination are almost wholly inert, except under some transient stimulus: the rude curiosity which the spectacle of nature involuntarily inspires is quite satisfied with the weakest attempts at theological explanation; and amusements, chiefly distinguished by violent muscular activity, rising at best to a manifestation of merely physical address, are as little favorable to the development of intelligence as of social qualities. The influence of civilization in perpetually improving the intellectual faculties is even more unquestionable than its effect on moral relations. The development of the individual exhibits to us in little, both as to time and degree, the chief phases of social development. In both cases, the end is to subordinate the satisfaction of the personal instincts to the habitual exercise of the social faculties, subjecting, at the same time, all our passions to rules imposed by an ever-strengthening intelligence, with the view of identifying the individual more and more with the species. In the anatomical view, we should say that the process is to give an influence by exercise to the organs of the cerebral systems, increasing in proportion to their distance from the vertebral column, and their nearness to the frontal region. Such is the ideal type which exhibits the course of human development, in the individual, and, in a higher degree, in the species. This view enables us to discriminate the natural from the artificial part of the process of development; that part being natural which raises the human to a superiority over the animal attributes; and that part being artificial by which any faculty is made to preponderate in proportion to its original weakness: and here we find the scientific explanation of that eternal struggle between our humanity and our animality which has been recognised by all who have made Man their study, from the earliest days of civilization till now, and embodied in many forms before its true character was fixed by the positive philosophy.

Rate of progress.

This, then, is the direction of the human evolution. The next consideration is the rate at which it proceeds, apart from any differences which may result from climate, race, or other modifying causes. Taking into the account only universal causes, it is clear that the speed must be in proportion to the combined influence of the chief natural conditions relating to the human organism first, and next to its medium. The invariableness—the evident impossibility of suspending these fundamental conditions must ever prevent our estimating their respective importance, though we may have a general conviction that our spontaneous development must be hastened or retarded by any change in these elementary influences, organic or inorganic; supposing, for instance, our cerebral system to be slightly inferior, in the frontal region; or our planet to become larger or more habitable. Sociological analysis can, by its nature, reach only to accessory conditions, which are rendered susceptible of estimate by their variations.

Ennui.

Among these secondary but permanent influences, which affect the rate of human development, *ennui* is the first which presents itself. Man, like other animals, can not be happy without a sufficient exercise of all his faculties, intense and persistent in proportion to the intrinsic activity of each faculty. The greater difficulty experienced by man in obtaining a development compatible with the special superiority of his nature renders him more subject than the other animals to that remarkable state of irksome languor which indicates at once the existence of the faculties and their insufficient activity, and which would become equally irreconcilable with a radical debility incapable of any urgent tendency, and with an ideal vigor, spontaneously susceptible of indefatigable exercise. A disposition at once intellectual and moral, which we daily see at work in nature endowed with any energy, must have powerfully accelerated the human expansion, in the infancy of humanity, by the uneasy excitement it occasioned either in the eager search for new sources of emotion, or in the more intense development of direct human activity. This secondary influence is not very marked till the social state is sufficiently advanced to make men feel a growing need to exercise the highest faculties, which are, as we have seen, the least energetic. The strongest faculties, which are the lowest, are so easily exercised that in ordinary circumstances they can hardly generate the *ennui* which would produce a favorable cerebral reaction. Savages, like children, are not subject to much *ennui* while their physical activity, which alone is of any importance to them, is not interfered with. An easy and protracted sleep prevents them, as if they were animals, from feeling their intellectual torpor in any irksome way. This brief notice of the influence of *ennui* was necessary, to show what its operation really amounts to in accelerating the speed of our social evolution. But perhaps the most important of all accelerating influences is the ordinary duration of human life, which I mention in the second place. There is no denying that our social progression rests upon death. I mean, the successive steps suppose the steady renewal of the agents of the general movement, which is almost imperceptible in the course of any single life, and becomes marked only on the succession of a new generation. Here again the social resembles the individual organism—being under the same necessity to throw off its constituent parts as they become, by the vital action itself, unfit for further use, and must be replaced by new elements. To illustrate this, we need not go so far as to suppose an indefinite duration of human life, which would presently put a stop to all progression whatever. It is enough to imagine it lengthened tenfold only, its respective periods preserving their present proportions. If the general constitution of the brain remained the same as now, there must be a retardation; though we know not how great, in our social development: for the perpetual conflict which goes on between the conservative instinct that belongs to age and the innovating instinct which distinguishes youth would be much more favorable than now to the former. From the extreme imperfection of the higher parts of our nature, even those who, in their prime, have contributed most to human progress can not preserve their due social eminence very long without becoming more or less hostile to the further progress which they can not assist. But an ephemeral life would be quite

Duration of human life.

as mischievous as a too protracted one, by giving too much power to the instinct of innovation. The resistance which this instinct now meets with from the conservatism of age compels it to accommodate its efforts to the whole of what has been already done. Without this check, our feeble nature, which has a strong repugnance to irksome and continuous labor, would be for ever proposing incomplete views and crude attempts, that could never ripen into mature projects and feasible acts: and this would be the inevitable state of things, if human life were reduced to a quarter, or even to half its present length. Such would be the consequences, in either case, if we suppose the constitution of the human brain to be much what it is now: and to suppose it essentially changed would be to carry us over into the region of hypothesis.

No justification is however afforded by these considerations to the optimism of the advocates of final causes: for if, in this as in every other case, the actual order is necessarily more or less accordant with the course of the phenomena, it is very far from being true that the arrangement of the natural economy is as good for its purposes as we can easily conceive. The slowness of our social development is no doubt partly owing to the extreme imperfection of our organism; but it is owing nearly as much to the brevity of human life: and there would be no risk to any other great arrangement if the duration of our life, while still limited by the conditions just specified, were doubled or trebled. We have hardly thirty years (and those beset with impediments) to devote to other purposes than preparation for life or for death; and this is a very insufficient balance between what Man can devise and what he can execute. Probably no one has ever nobly devoted himself to the direct advancement of the human mind without bitterly feeling how time, employed to the utmost, failed him for the working out of more than an insignificant part of his conceptions. It will not do to say that the rapid succession of coadjutors compensates for this restriction of individual activity. Important as this compensation is, it is very imperfect, both on account of the loss of time in preparing each successor, and because the precise continuance of the work by different persons, occupying different points of view, is impossible, and the more out of the question exactly in proportion to the value of the new coadjutors. In the simplest material operations, no man's work has ever been carried on by others precisely as he would have done it himself; and the more difficult and lofty labors, which require intellectual and moral forces to complete them, are much more in need of a persistent unity in their management. These intellectual and moral forces no more admit of partition and addition by successors than by contemporaries; and, whatever the advocates of the indefinite distribution of individual efforts may say, a certain degree of concentration is necessary to the accomplishment of human progress.

Increase of population.

Another cause which affects the rate of progress is the natural increase of population, which contributes more than any other influence to accelerate the speed. This increase has always been regarded as the clearest symptom of the gradual amelioration of the human condition; and nothing can be more unquestionable when we take the whole race into the account; or at least, all the nations which have any mutual interest: but this is not the view with which my argument is concerned. I have to consider only the progressive condensation of our species as a last general element concurring in the regulation of our rate of social progress. It is clear that by this condensation, and especially in its early stages, such a division of employments is favored as could not take place among smaller numbers: and again, that the faculties of individuals are stimulated to find subsistence by more refined methods: and again, that society is obliged to act with a firmer and better-concerted energy against the expansion of individual divergences. In view of these considerations, I speak, not of the increase of the numbers of mankind, but of their concentration upon a given space, according to the special expression which I have made use of, and which is particularly applicable to the great centres of population, whence, in all ages, human progression has started. By creating new wants and new difficulties, this gradual concentration develops new means, not only of progress but of order, by neutralizing physical inequalities, and affording a growing ascendency to those intellectual and moral forces which are suppressed among a scanty population. If we go on to inquire into the effect of a quicker or slower concentration, we shall perceive that the social movement is further accelerated by the disturbance given to the old antagonism between the conservative and the innovating instincts, —the last being strongly reinforced. In this sense, the sociological influence of a more rapid increase of population is in analogy with that which we have just been considering in regard to the duration of life; for it is of little consequence whether the more frequent renewal of individuals is caused by the short life of some, or the speedier multiplication of others; and what was said in the former case will suffice for the latter. It must be observed, however, that if the condensation and rapidity were to pass beyond a certain degree, they would not favor, but impede this acceleration. The condensation, if carried too far, would render the support of human life too difficult; and the rapidity, if extreme, would so affect the stability of social enterprises as to be equivalent to a considerable shortening of our life. As yet, however, the increase of population has never nearly reached the natural limits at which such inconveniences will begin; and we have really no experience of them, unless in a few exceptional cases of disturbance caused by migrations, ill-managed as to their extent of numbers and of time. In an extremely distant future, our posterity will have to conisder the question, and with much anxiety; because, from the smallness of the globe, and the necessary limitation of human resources, the tendency to increase will become extremely important, when the human race will be ten times as numerous as at present, and as much condensed everywhere as it now is in the west of Europe. Whenever that time comes, the more complete development of human nature, and the more exact knowledge of the laws of human evolution, will no doubt supply new means of resistance to the danger; means of which we can form no clear conception, and about which it is not for us to decide whether they will, on the whole, afford a sufficient compensation.

These are not all the accelerating influences which could be mentioned; but they are the chief; and they are enough for us, in our abstract view of our subject. I have now only to exhibit the main subordination which the different aspects of human development must mutually present.

The order of evolution.

Though the elements of our social evolution are connected, and always acting on each other, one must be preponderant, in order to give an impulse to the rest, though they may, in their turn, so act upon it as to cause its further expansion. We must find out this superior element, leaving the lower degrees of subordination to disclose themselves as we proceed: and we have not to search far for this element, as we can not err in taking that which can best be conceived of apart from the rest, notwithstanding their necessary connection, while the consideration of it would enter into the study of the others. This double characteristic points out the intellectual evolution as the preponderant principle. If the intellectual point of view was the chief in our statical study of the organism, much more must it be so in the dynamical case. If our reason required at the outset the awakening and stimulating influence of the appetites, the passions, and the sentiments, not the less has human progression gone forward under its direction. It is only through the more and more marked influence of the reason over the general conduct of Man and of society, that the gradual march of our race has attained that regularity and persevering continuity which distinguish it so radically from the desultory and barren expansion of even the highest of the animal orders, which share, and with enhanced strength, the appetites, the passions, and even the primary sentiments of Man. If the statical analysis of our social organism shows it resting at length upon a certain system of fundamental opinions, the gradual changes of that system must affect the successive modifications of the life of humanity: and this is why, since the birth of philosophy, the history of society has been regarded as governed by the history of the human mind. As it is necessary, in a scientific sense, to refer our historical analysis to the preponderant evolution, whatever it may be, we must in this case choose, or rather preserve, the general history of the human mind as the natural guide to all historical study of humanity. One consequence of the same principle,—a consequence as rigorous but less understood,—is that we must choose for consideration in this intellectual history, the most general and abstract conceptions, which require the exercise of our highest faculties. Thus it is the study of the fundamental system of human opinions with regard to the whole of phenomena,—in short, the history of Philosophy, whatever may be its character, theological, metaphysical, or positive,—which must regulate our historical analysis. No other department of intellectual history, not even the history of the fine arts, including poetry, could, however important in itself, be employed for this object; because the faculties of expression, which lie nearer to the affective faculties, have always, in their palmiest days, been subordinated, in the economy of social progress, to the faculties of direct conception. The danger (which is inherent in every choice, and which is the least in the choice that I have made) of losing sight of the interconnection of all the parts of human development, may be partly guarded against by frequently comparing them, to see if the variations in any one corresponds with equivalent variations in the others. I believe we shall find that this confirmation is eminently obtainable by my method of historical analysis. This will be proved at once if we find that the development of the highest part of human interests is in accordance with that of the lowest,—the intellectual with the material. If there is an accordance between the two extremes, there must be also between all the intermediate terms.

We have indicated the general direction of the human evolution, its rate of progress, and its necessary order. We may now proceed at once to investigate the natural laws by which the advance of the human mind proceeds. The scientific principle of the theory appears to me to consist in the great philosophical law of the succession of the three states—the primitive theological state, the transient metaphysical, and the final positive state—through which the human mind has to pass, in every kind of speculation. This seems to be the place in which we should attempt the direct estimate of this fundamental law, taking it as the basis of my historical analysis, which must itself have for its chief object to explain and expand the general notion of this law by a more and more extended and exact application of it in the review of the entire past of human history. I hope that the frequent statement and application of this law throughout the preceding part of my work will enable me to condense my demonstration of it here, without impairing its distinctness, or injuring its efficacy in such ulterior use as we shall have to make of it.

Law of the Three Periods.

The reader is by this time abundantly familiar with the interpretation and destination of the law. All thoughtful persons can verify for themselves its operation in individual development, from infancy to manhood, as I pointed out at the beginning of this work. We can test it, as we have tested other laws, by observation, experiment, and comparison. I have done so through many years of meditation; and I do not hesitate to say that all these methods of investigation will be found to concur in the complete establishment of this historical proposition, which I maintain to be as fully demonstrated as any other law admitted into any other department of natural philosophy. Since the discovery of this law of the three periods, all positive philosophers have agreed on its special adaptation to the particular science in which each was interested, though all have not made the avowal with equal openness. The only objections that I have encountered have related merely to the universality of its application. I hold it to be now implicitly recognised with regard to all the sciences which are positive: that is, the triple evolution is admitted in regard to all cases in which it is accomplished. It is only in regard to social science that its application is supposed to be impossible: and I believe the objection to signify nothing more than that the evolution is in this case incomplete. Social science has, with all its complexity, passed through the theological state, and has almost everywhere fully attained the metaphysical; while it has nowhere yet risen to the positive, except in this book. I shall leave the assertion of the law in regard to sociology to the demonstration which my analysis will afford: for those who can not perceive in this volume, as a whole, the nascent realization of this last philosophical process could not be convinced by argument. Leaving the historical verification of the law, therefore, to the reader, I invite attention to its philosophical explanation. It is not enough that the succession of the three states is a general fact. Such generality would go for more in any other science than in sociology, because, as we have seen, our biological philosophy enables us to conceive of all the main relations of social phenomena *à priori*, independently of their direct investigation, and we need confirmation of our conceptions by a direct knowledge of human nature and experience. An *à-priori* conception of a law so important as this is of the deepest interest in the study of social dynamics; and, to confirm it, we must carefully mark the general grounds, derived from an exact knowledge, which have rendered indispensable on the one hand, and inevitable on the other, that succession of social phenomena which take their course under the operation of this law. The logical grounds have already been assigned, at the outset of the work, and repeatedly since: and it is with the moral and social that we now have to do, and we can review them without subjecting ourselves to the reproach of severing the parts of a philosophical demonstration which are in their nature bound up together.

The Theological period.

The necessity of the intellectual evolution I assert lies in the primary tendency of Man to transfer the sense of his own nature into the radical explanation of all phenomena whatever. Philosophers tell us of the fundamental difficulty of knowing ourselves; but this is a remark which could not have been made till human reason had achieved a considerable advance. The mind must have attained to a refined state of meditation before it could be astonished at its own acts—reflecting upon itself a speculative activity which must be at first incited by the external world. If, on the one hand, Man must begin by supposing himself the centre of all things, he must, on the other hand, next set himself up as a universal type. The only way that he can explain any phenomena is by likening them, as much as possible, to his own acts—the only ones whose mode of production he can suppose himself, by the accompanying sensations, to understand. We may therefore set up a converse statement, and say that Man knows nothing but himself; and thus, his philosophy, in his earliest stage, consists principally in transferring this spontaneous unity, more or less fortunately, into all subjects which may present themselves to his nascent attention. It is the highest proof of his philosophical maturity when he can, at length, apply the study of external nature to his own. When I laid this down as the basis of biological philosophy, I intimated the extreme rarity of such an attainment. At the outset, under the inverse process, the universe is always subordinated to Man, in speculative as well as in active respects. We shall not have attained a truly rational position till we can reconcile these two great philosophical views, at present antagonistic, but admitting of being made mutually complementary, and, in my opinion, prepared for being so, from this time forward. Such a harmony is even now barely conceivable in the brightest insight of philosophical genius, and there could have been no choice between the two courses in the earliest days of human development. The starting-point must have been that which alone was naturally possible. This was the spontaneous origin of the theological philosophy, the elementary spirit of which consists in explaining the intimate nature of phenomona, and their mode of production, and in likening them, as much as possible, to the acts of human will, through our primary tendency to regard all beings as living a life analogous to our own, and often superior, from their greater habitual energy. This procedure is so eminently exclusive, that men are unable to emancipate themselves from it, even in the most advanced stages of evolution, except by abandoning altogether these inaccessible researches, and restricting themselves to the study of the laws of phenomena, apart from their causes. Whenever, at this day, the human mind attempts to pass these inevitable limits, it involuntarily falls again into the primary errors, even in regard to the simplest phenomena, because it recurs to an aim and point of view essentially analogous, in attributing the production of phenomena to special volitions, internal, or more or less external. One case presents itself as an example, of the simplest scientific character—that of the memorable philosophical error of the illustrious Malebranche in regard to the explanation of the mathematical laws of the elementary collision of solid bodies. If such a mind, in such an age, could explain such a theory in no other way than by an express recurrence to the continuous activity of a direct and special providence, we can not doubt the tendency of our reason toward a radically theological philosophy whenever we attempt to penetrate, on any ground whatever, the intimate nature of phenomena.

This inevitableness of the theological philosophy is its most radical property, and the first cause of its long ascendency.

Intellectual influence of the Theological philosophy.

We have seen before that it was necessary, as the only possible beginning of our intellectual evolution; for the facts which must form the basis of a positive theory could not be collected to any purpose without some preliminary theory which should guide their collection. Our understanding can not act without some doctrine, false or true, vague or precise, which may concentrate and stimulate its efforts, and afford ground for enough speculative continuity to sustain our mental activity. Our meteorological *observations*, as we call them, show us how useless may be vast compilations of facts, and how really unmeaning, while we are destitute of any theory whatever. Those who expect that the theory will be suggested by the facts, do not understand what is the course necessarily pursued by the human mind, which has achieved all real results by the only effectual method,—of anticipating scientific observations by some conception (hypothetical in the first instance) of the corresponding phenomena. Such a necessity has already been shown to be especially marked in the case of social speculations, not only from their complexity, but from the peculiarity that a long preparatory development of the human mind and of society constitutes the phenomena of the case, independently of all preparation of observers, and all accumulation of observations. It may be worth observing, that all the partial verifications of this fundamental proposition that we meet with in the different sciences confirm each other, on account of our tendency to unity of method and homogeneousness of doctrine, which would incline us to extend the theological philosophy from one class of speculations to another, even if we should not so treat each one of them separately.

The original and indispensable office of the theological philosophy is then to lead forth the human mind from the vicious circle in which it was confined by the two necessities of observing first, in order to form conceptions, and of forming theories first, in order to observe. The theological philosophy afforded an issue by likening all phenomena whatever to human acts; directly, in the first instance, by supposing all bodies to have a life more or less like our own, and indirectly afterward, by means of the more durable and suggestive hypothesis which adds to the visible system of things an invisible world, peopled by superhuman agents, who occasion all phenomena by their action on matter, otherwise inert. The second stage is especially suitable to the human mind which begins to feel its difficulties and its needs; for every new phenomenon is accounted for by the supposition of a fresh volition in the ideal agent concerned, or, at most, by easy creation of a new agent. However futile these speculations may now appear, we must remember that, in all times and everywhere, they have awakened human thought by offering to it the only material which it could at first accept. Besides that there was no choice, the infant reason can be interested by nothing but sublime solutions, obtained without any deep and sustained conflict of thought. We, at this day, find ourselves able, after suitable training, to devote ourselves to the study of the laws of phenomena, without heed to their first and final causes; but still we detect ourselves occasionally yielding to the infantine curiosity which pretends to a power of knowing the origin and the end of all things. But such severity of reason as we are capable of has become attainable only since the accumulation of our knowledge has yielded us a rational hope of finally discovering the natural laws that were altogether out of reach, in the early states of the human mind; and the only alternative from total inactivity was, in those days, in the pursuit of the inaccessible subject which are represented by the theological philosophy.—The moral and social grounds of this philosophy were as necessary as the intellectual. Its moral influence was to inspire Man with confidence enough for action, by animating him with a sense of a position of supremacy. There is something astonishing in the contrast between the actual powers of Man in an infant state and the indefinite control which he aspires to exercise over external nature; just as there is in his expectation of understanding matters which are inaccessible to reason. The practical and the speculative expectation alike belong to the theological philosophy. Supposing all phenomena to be regulated by superhuman will, Man may hope to modify the universe by his desires; not by his personal resources, but by the access which he believes himself to have to the imaginary beings whose power is unlimited: whereas, if he was aware from the beginning that the universe is subject to invariable laws, the certainty that he could no more influence than understand them would so discourage him that he would remain for ever in his original apathy, intellectual and moral. We find ourselves able to dispense with supernatural aid in our difficulties and sufferings, in proportion as we obtain a gradual control over Nature by a knowledge of her laws: but the early races of men were in an opposite condition. They could obtain confidence, and therefore courage, only from above, and through the illusion of an illimitable power residing there, which could, on any occasion, afford them irresistible aid. I am not referring now to any hope of a future life. We shall see presently that it was not till a much later period that that hope exercised any important social influence: and even in more recent times, we shall find that the effect of the religious spirit on the conduct of human life proceeds much more from belief in actual and special immediate aid than from the uniform perspective of a remote future existence. This seems to me the leading aspect of the remarkable state which is produced in the human brain by the important intellectual and moral phenomenon of prayer; the admirable properties of which, when it has attained its full physiological efficacy, are very manifest in the earliest stage of progress. After a long decline of the religious spirit, the notion of *miracle* was naturally formed, to characterize the events which had become exceptional, and were attributed to divine intervention: but the very conception shows that the general principle of natural laws had become familiar, and even preponderant, because the only sense of *miracle* was a transient suspension of natural laws.

While the theological philosophy was all in all, there were no miracles, because everything was equally marvellous, as we see by the artless descriptions of ancient poetry, in which the commonest incidents are mixed up with the most monstrous prodigies, and undergo analogous explanations. Minerva intervenes to pick up the whip of a warrior in military games, as well as to protect him against a whole army: and in our own time, the devotee is as importunate in praying for his smallest personal convenience as for the largest human interests. In all ages, the priest has been more occupied with the solicitations of his flock about immediate favors of Providence than with their care for their eternal state. However this may be, we see that it is a radical property of the theological philosophy to be the sole support and stimulus of Man's moral courage, as well as the awakener and director of his intellectual activity.—To this we must add, as another attraction of Man to this philosophy, that the affective influence comes in to fortify the speculative. Feeble as are the intellectual organs, relatively considered, the attractive moral perspective of an unbounded power of modifying the universe, by the aid of supernatural protectors, must have been most important in exciting mental action. In our advanced state of scientific progress, we can conceive of the perpetual pursuit of knowledge for the sake of the satisfaction of intellectual activity, joined to the tranquil pleasure which arises from the discovery of truth: yet it is doubtful whether such natural stimulus as this would always suffice without collateral instigations of glory, of ambition, or of lower and stronger passions, except in the case of a very few lofty minds; and with them, only after training in the requisite habits. And nothing of this kind can be supposed possible in the early days, when the intellect is torpid and feeble, and scarcely accessible to the strongest stimulus; nor yet afterward, when science is so far advanced as to have attained some speculative success. In the working out of such speculation, the mental activity can be sustained by nothing short of the fictions of the theological philosophy about the supremacy of man and his unbounded empire over external nature; as we have seen in regard to astrology and alchemy. In our own time, when there are enlightened men who hold such delusions in regard to social speculations alone, we see how irrationally they expect to modify at will the whole course of political phenomena, in which they could not take any adequate scientific interest without such an expectation. What we see of the influence of this view in maintaining the old polities may give us some faint idea of its power when it pervaded every part of the intellectual system, and illusion beset the reason of Man, whichever way he turned. Such then was the moral operation of the theological philosophy,—stimulating Man's active energy by the offer, in the midst of the troubles of his infantine state, of absolute empire over the external world, as the prize of his speculative efforts.

Social influences of the Theological philosophy.

The social evidences under this head will be fully treated in the following chapters, so that we may dismiss them now with a very short notice, important as they are; and the more easily, because this class of evidences is the most indisputable of the three. There are two views which must be considered, in relation to the high social office of the theological philosophy: first, its function in organizing society; and next, its provision for the permanent existence of a speculative class.—As to the first, we must perceive that the formation of any society, worthy to be so called, supposes a system of common opinions, such as may restrain individual eccentricity; and such an influence, if needful now, when men are connected together by such a concurrence of obligations as high civilization introduces, must be absolutely indispensable in the infancy of society, when families adhere to each other so feebly, by means of relations as precarious as they are defective. No concurrence of interests, nor even sympathy in sentiment, can give durability to the smallest society, if there be not intellectual unanimity enough to obviate or correct such discordance as must inevitably arise. It has been shown that, indolent as our intellectual faculties are in comparison with the others, reason must rule, not domestic but social, and yet more political life: for through it alone can there be any organization of that reaction of society on the individual which appoints the function of government, and absolutely requires a system of common opinions about nature and Man. Such a system, then, is a political necessity; and especially in the infancy of society. But, on the other hand, we must admit that the human mind, having thus furnished a basis for social organization, must depend for its further development on society itself, whose expansion is really inseparable from that of human intelligence. Here we see that society is in a vicious circle in a political, as well as a logical view, through the opposition of two equal necessities; and here, again, the only possible issue is afforded by the theological philosophy. It directs the first social organization, as it first forms a system of common opinions, and by forming such a system. Because we see it now in such a state of decomposition that its advocates lose sight of the unity of opinions that it once secured, and are themselves involved in intellectual discordance, we must not forget how, in those days of vigor by which it must be judged, it established an intellectual communion which constituted its most remarkable political function. The police consideration of a future life is wrongly attributed to this period of human society. It arose long after, and was of very inferior importance to the intellectual agreement which preceded it: and its operation would not be so erroneously exaggerated, but that religion has so far faded out of men's minds as to leave no other strong habitual remembrance than of its grossest impressions.

Institution of a speculative class.

Another way in which the theological philosophy was politically indispensable to human progress was by instituting, in the midst of society, a special class regularly devoted to speculative activity. In this view, the social supremacy of the theological philosophy has lasted to our own time. It is scarcely possible for us to form any but an indirect idea of the difficulty of establishing, in the earliest period of society, any permanent division between theory and practice, such as is effected by the existence of a class regularly occupied with speculation. Even now, amidst all the refinement of our mental habits, we find extreme difficulty in duly estimating any new operation which has no immediate practical bearing: and by this we may imperfectly understand how impossible it was, in the remotest ages, to institute among populations of warriors and slaves a corporation that should be disengaged from military and industrial employments, and whose activity should be mainly of an intellectual kind. Such a class could, in those times, have been neither established nor tolerated if it had not been introduced in the natural course of social movement, and invested with authority beforehand by the influence of the theological philosophy. The political function of that philosophy thus was to establish a speculative body whose social existence not only admitted of no preparatory discussion, but was itself an indispensable preparation for the regular organization of all other classes. Whatever might have been the confusion of intellectual labor, and the inanity of the leading investigations of the sacerdotal orders, it is not the less true that the human mind owes to them the first effectual separation between theory and practice, which could take place in no other manner. Mental progress, by which all other progress is directed, would certainly have been destroyed at its birth, if society had continued to be composed of families engaged in the cares of material existence, or, as the only alternative, in the excitement of a brutal military activity. Any spiritual expansion supposes the existence of a privileged class, enjoying the leisure indispensable to intellectual culture, and at the same time urged, by its social position, to develop to the utmost the kind of speculative activity compatible with the primitive state of humanity; and this description is answered by the sacerdotal institution established by the theological philosophy. Though, in the decrepitude of the old philosophy, we see the theological class sunk in mental lethargy, we must not forget that, but for their activity in the days of its prime, human society would have remained in a condition much like that of a company of superior monkeys. By forming this speculative class, then, the theological philosophy fulfilled the political conditions of a further progression of the human mind.

Such are the qualities, intellectual, moral, and social, which secured the supremacy of the theological philosophy, at the outset of human progress. This is the only part of my sociological demonstration which is at all open to dispute; and this is one reason why I have dwelt so long upon it: but it is not the only reason. Another and a greater is that this view contains the radical principle of the whole demonstration, the remainder of which will not detain us long.

The Positive stage.

If this starting-point of human development has been placed beyond dispute, the final or positive stage does not admit of it. We have seen enough of the establishment of the positive philosophy in other departments to be satisfied of its destined prevalence in sociology. For the same reasons which explain and justify the early supremacy of the theological philosophy, we see that it must be a provisional state, for its supremacy was owing to its aptitude to meet the needs of a primitive state of humanity; and those needs are not the same, nor requiring the same philosophy to satisfy them, as those which arise in a more advanced stage of the human evolution. After having awakened human reason, and superintended its progress, in the absence of a more real philosophy, theology began to repress the human mind from the first moment of its coming into direct antagonism with the positive philosophy. And in the same way, in its moral relations, it imparted at first a consolatory confidence and active energy, which have become transmuted, by too long a duration, into oppressive terror and a faint apathy which have been too common a spectacle since it has been driven to struggle to retain its hold, instead of extending its dominion. There is no more question of the moral than of the intellectual superiority and final supremacy of the positive philosophy, capable as it is of developing in us an unshaken vigor and a deliberate steadfastness, directly derived from our own nature, without any external assistance, or any imaginary hinderance. And again, in regard to its social bearings, though the ascendency of the theological philosophy lasted longer on this ground than on the other two, it is evident enough at present that, instead of uniting men, which was its proper function at first, it now divides them, so that, after having created speculative activity, it has ended with radically hindering it. The function of reuniting, as of stimulating and directing, belongs more and more, as religious belief declines, to the conceptions of positive philosophy, which alone can establish that intellectual community all over the world on which the great future political organization is to be grounded. The intellectual destination of the two philosophies has been sufficiently established in our review of all the departments of natural philosophy. Their moral and social destination will be illustrated in succeeding chapters of this work. My historical analysis will explain to us the continuous decline of the one and the corresponding rise of the other, from the earliest period of human progression. It may appear paradoxical to regard the theological philosophy as in a steadily-declining state intellectually, at the very time that it was fulfilling its most exalted political mission; but we shall find satisfactory scientific evidence that Catholicism, its noblest social work, must necessarily be its last effort, on account of the germs of disorganization which must thenceforth grow more and more rapidly. We need here, therefore, only assign the general principle of the inevitable tendency of the human mind toward an exclusive positive philosophy, throughout the whole range of the intellectual system.

Attempted union of the two philosophies.

The general, like the individual human mind, is governed by imagination first, and then, after a sufficient exercise of the faculties at large, more and more by reason. The same grounds on which the process takes place in the individual case determine that of the whole species; and with the more certainty and power on account of the greater complexity and perpetuity of the social organism. Supreme as the theological philosophy once was, it is certain that such a method of philosophizing was resorted to only because no other was possible. Wherever there has been a choice, in regard to any subject whatever, Man has always preferred the study of the laws of phenomena to that of their primary causes, though prior training, which there has been no rational education adapted to counteract, has often occasioned lapse into his old illusions. Theological philosophy has, however, never been absolutely universal. That is, the simplest and commonest facts in all classes of phenomena have always been supposed subject to natural laws, and not to the arbitrary will of supernatural agents. Adam Smith made the remark that there never was, in any age or country, a god of Weight. In more complex cases, if only the relations of phenomena are seen to be invariable, the most superficial observer recognises the presence of law. Even among moral and social phenomena, where the entrance of positive philosophy has been interdicted, we are all obliged to act daily on the supposition of natural laws, in order to conduct the common affairs of life, for all forecast would be impossible if we supposed every incident to be ascribable to supernatural agency, and no other resource therefore possible than prayer, for influencing the course of human actions. It is even noticeable that the principle of the theological philosophy itself lies in the transference to the phenomena of external nature of the first beginnings of the laws of human action; and thus the germ of the positive philosophy is at least as primitive as that of the theological philosophy itself, though it could not expand till a much later time. This idea is very important to the perfect rationality of our sociological theory; because, as human life can never present any real creation, but only a gradual evolution, the final spread of the positive spirit would be scientifically incomprehensible, if we could not trace its rudiments from the very beginning. From that scarcely-appreciable presence at the beginning, the rise of the positive spirit has been recognisable, in proportion to the extension and generalization of our observations, and the theological philosophy has been slowly but steadily driven back within the narrowing limits of phenomena whose natural laws were still unknown. Thus was the function of the old philosophy clearly a provisional one—to maintain our mental activity by the only exercise open to it, till the positive philosophy should usher it into the wide field of universal knowledge, made accessible to the whole race. This destination has only recently exhibited itself in an unquestionable way since the disclosure of natural laws in phenomena, so numerous and so various as to suggest the necessary existence of analogous laws in all other departments, however remote their actual discovery may be.

It does not follow, from anything that I have said, that the two philosophies were always visibly opposed to each other. On the contrary, the physical study must have succumbed to the theological spirit if they had seemed at the outset to be incompatible. In fact the study of the laws of phenomena appeared, for a long course of time, to agree very well with the investigation into their causes. It was only when observations became more connected, and disclosed important relations, that the radical opposition of the two doctrines began to be felt. Before the antagonism was avowed, the positive spirit manifested its repugnance to the futile absolute explanations of the theological philosophy; and the theological spirit lavished its disdain on the circumspect march and modest investigations of the new school; while still there was no idea that the study of real laws was irreconcileable with that of essential causes. When natural laws of considerable scope were at length discovered, the incompatibility became clear between the preponderance of imagination and that of reason, between the absolute spirit and the relative; and, above all, between the ancient hypothesis of the sovereign direction of events by any arbitrary will, and the growing certainty that we can foresee and modify them by the rational access of human wisdom. It is only in our own time that the antagonism has been extended to all parts of the intellectual field; and even up to the last moment, the students of special subjects have believed that by confining themselves to the investigation of natural laws, and paying no attention to the nature of beings and mode of production of phenomena, they might find physical researches compatible with the explanations of theology; while theology made its own concessions in the form of a provisional notion of a universal providence, combined with special laws which it had imposed on itself. The conduct of Catholicism, in interdicting the habitual use of miracle and prophecy, which prevailed so largely in ancient times, seems to me to present, in religious affairs, a transient situation analogous to that which is exhibited by what is called the institution of constitutional monarchy in the political world; each being, in its own way, an indisputable symptom of decline. However this may be, the insufficiency of the theological philosophy manifests itself to popular observation in that form of popular evidence which can alone reach the majority of mankind,—in its comparison with its opponent in the application of means. The positive philosophy enables us to foresee and to modify natural events, and thus satisfies, more and more, as it advances, the most urgent intellectual needs of humanity, while the ancient philosophy remains barren; so that its fanciful explanations are more and more neglected, while the new philosophy obtains a perpetually firmer hold on the public reason. Those who have remained faithful in their attachment to the theological philosophy make no practical use of it in their daily life, and ground their predilection for it on its characteristic generality: so that when its antagonist shall have become systemized as fully as it is destined to be, the ancient philosophy will have lost the last attribute which has ever entitled it to social supremacy.

The Metaphysical Period.

We have now only to take a cursory survey of the intermediate state. I have pointed out more than once before, that any intermediate state can be judged of only after a precise analysis of the two extremes. The present case is a remarkable illustration of this necessity; for if it is once admitted that the human mind must set out from the theological state, and arrive certainly at the positive, we may easily understand how it must pass through the metaphysical, which has no other destination than to afford a transition from the one to the other. The bastard and mobile character of the metaphysical philosophy fits it for this office, as it reconciles, for a time, the radical opposition of the other two, adapting itself to the gradual decline of the one, and the preparatory rise of the other, so as to spare our dislike of abrupt change, and to afford us a transition almost imperceptible. The metaphysical philosophy takes possession of the speculative field after the theological has relinquished it, and before the positive is ready for it: so that in each particular case, the dispute about the supremacy of any of the three philosophies is reduced to the mere question of opportuneness, judged by a rational examination of the development of the human mind. The method of modification consists in substituting gradually the entity for a deity when religious conceptions become so generalized as to diminish perpetually the number of supernatural agents, as well as their active intervention, and at length arrive, professedly if not really, at rigorous unity. When supernatural action loses its original speciality, it consigns the immediate direction of the phenomenon to a mysterious entity, at first emanating from itself, but to which daily custom trains the human mind to refer more and more exclusively the production of each event. This strange process has favored the withdrawal of supernatural causes, and the exclusive consideration of phenomena; that is, the decline of the theological and the rise of the positive spirit. Beyond this, the general character of this philosophy is that of the theological, of which it is only a modification, though the chief. It has an inferior intellectual consistency, and a much less intense social power; so that it is much better adapted for a critical function than for any real organization: and it is those very qualities which disable it for resistance to the growth of the positive spirit. On the one hand the increasing subtilty of metaphysical speculations is for ever reducing their characteristic entities to mere abstract denominations of the corresponding phenomena, so as to render their own impotence ridiculous when they attempt explanations: a thing which would not have been possible, in an equal degree, with purely theological forms. On the other hand, its deficiency of organizing power, in consequence of its radical inconsistency, must prevent its maintaining any such political struggle as theology maintained against the spread of positive social philosophy. However, it obtains a respite by its own equivocal and mobile nature, which enables it to escape from rational discussion even more than the theological philosophy itself, while the positive spirit is as yet too imperfectly generalized to be able to attack the only substantial ground of their common authority,—the universality which they can boast, but which it has not. However this may be, we must admit the aptitude of metaphysics to sustain, provisionally, our speculative activity on all subjects till it can receive more substantial aliment; at the same time carrying us over from the theological *régime* farther and farther in the direction of the positive. The same aptitude appears in its political action. Without overlooking the serious intellectual and moral dangers which distinguish the metaphysical philosophy, its transitional quality accounts to us for the universal ascendency which it has provisionally obtained among the most advanced societies, which can not but have an instinctive sense of some indispensable office to be fulfilled by such a philosophy in the evolution of humanity. The irresistible necessity of this temporary phase is thus, on all grounds, as unquestionable as it could be prior to the direct analysis to which it will be subjected in the course of our historical review.

Co-existence of the three Periods.

During the whole of our survey of the sciences, I have endeavored to keep in view the great fact that all the three states, theological, metaphysical, and positive, may and do exist at the same time in the same mind in regard to different sciences. I must once more recall this consideration, and insist upon it; because in the forgetfulness of it lies the only real objection that can be brought against the grand law of the three states. It must be steadily kept in view that the same mind may be in the positive state with regard to the most simple and general sciences; in the metaphysical with regard to the more complex and special; and in the theological with regard to social science, which is so complex and special as to have hitherto taken no scientific form at all. Any apparent contradiction must certainly arise, even if it could be shown to exist, from the imperfection of our hierarchical arrangement, and not from the law of evolution itself. This once fully understood, the law itself becomes our guide in further investigation, as every proved theory does, by showing us by anticipation, what phenomena to look for, and how to use those which arise: and it supplies the place of direct exploration, when we have not the means of investigation. We shall find that by this law alone can the history of the human mind be rendered intelligible. Having convinced ourselves of its efficacy in regard to all other sciences, and in interpreting all that has yet come to pass in human history, we must adhere to it steadily, in analyzing the present, and in forming such anticipation of the future as sociology, being a real science, enables us to rely upon.

To complete my long and difficult demonstration, I have only now to show that material development, as a whole, must follow a course, not only analogous, but perfectly correspondent with that of intellectual development, which, as we have seen, governs every other.

Corresponding material development.

All political investigation of a rational kind proves the primitive tendency of mankind, in a general way, to a military life; and to its final issue in an industrial life. No enlightened mind disputes the continuous decline of the military spirit, and the gradual ascendency of the industrial. We see now, under various forms, and more and more indisputably, even in the very heart of armies, the repugnance of modern society to a military life. We see that compulsory recruiting becomes more and more necessary, and that there is less and less voluntary persistance in that mode of life. Notwithstanding the immense exceptional development of military activity which was occasioned by anomalous circumstances at the beginning of the present century, our industrial and pacific instincts have returned to their regular course of expansion, so as to render us secure of the radical tranquillity of the civilized world, though the peace of Europe must often appear to be endangered through the provisional deficiency of any systematic organization of international relations; a cause which, though insufficient to produce war, keeps us in a state of frequent uneasiness. We need not then go over again the proof of the first and last terms of the evolution: which will be abundantly illustrated by the historical analysis that I shall offer. We have only to refer the facts of human experience to the essential laws of human nature, and the necessary conditions of social development:—a scientific procedure which has never yet been attempted.

Primitive military life.

As long as primitive Man was averse from all regular toil, the military life alone furnished a field for his sustained activity. Apart from cannibalism, it offered the simplest means of subsistence. However deplorable the necessity, its universal prevalence and continuous development, even after subsistence might have been obtained by other means, proves that the military *régime* must have had some indispensable, though provisional office to fulfil in the progression of the race. It was indeed the only one under which human industry could make a beginning; in the same way that the scientific spirit could not have arisen without the protection of the religious. The industrial spirit supposed the existence of a considerable social development, such as could not have taken place till isolated families had been connected by the pursuits of war. The social, and yet more the political properties of military activity are, in their early stages, perfectly clear and decisive, and, in short, fully appropriate to the high civilizing function which they had to fulfil. It was thus that habits of regularity and discipline were instituted, and the families of men were brought into association for warlike expeditions, or for their common defence. The objects of association could not possibly be more obvious or urgent, nor the elementary conditions of concurrence more irresistible. In no other school could a primitive society learn order; as we may see at this day in the case of those types of ancient humanity,—the exceptional individuals who can not now be made amenable to industrial discipline. This ascendency of the military spirit was indispensable, not only to the original consolidation of political society, but yet more to its continuous extension, which could not otherwise have taken place but with excessive slowness; and such extension was, to a certain degree, indispensable to the final development of human industry. Thus, then, we find humanity involved in the same kind of vicious circle with regard to its temporal as we saw it to be with its spiritual progress; and in both cases an issue was afforded by the fortunate expansion of a preliminary tendency. In fact, the necessary basis of the military *régime* has everywhere been the individual slavery of the producing class, by which warriors were allowed the full and free development of their activity. We shall see hereafter that the great social operation which was to be accomplished, in due time, by the continuous progression of a military system, powerfully instituted and wisely carried out, must have failed in its earliest stages. We shall also see how this ancient slavery was the necessary preparation for the final prevalence of the industrial life, by imposing on the majority of the race, irresistibly and exclusively, that toil to which Man is constitutionally averse, though an ultimate condition of laborious perseverance was in store for all. To view the case without prejudice, we must transport ourselves to those primitive times, and not regard the slavery of that age with the just horror with which we view that of modern times,—the colonial slavery of our day, which is truly a social monstrosity, existing as it does in the heart of an industrial period, subjecting the laborer to the capitalist in a manner equally degrading to both. The ancient slavery was of the producer to the warrior; and it tended to develop their respective energies, so as to occasion their final concurrence in the same social progression.

Primitive Slavery.

The Military *régime* provisional.

Necessary as this military *régime* was, it was not the less merely provisional. While industrial activity has the fine quality of bearing the most energetic extension among all individuals and nations without making the rise of the one irreconcilable with that of the other, it is evident that the exaltation of the military life among any considerable portion of the race must occasion the restriction of all the rest; this being, in fact, the proper function of the *régime* in regard to the whole field of civilization. Thus, while the industrial period comprehends the whole term of human progress under natural laws—that is, the whole future that we can conceive of—the military period could last no longer than the formation of those preparatory conditions which it was its function to create. This end was attained when the chief part of the civilized world was at length united under the same rule; that is, in regard to Europe, when Rome had completed its conquests. From that time forward, military activity had neither object nor aliment; and from that time forward, therefore, it declined, so as no longer to disguise that gradual rise of the industrial spirit, which had been preparing during the interval. But, notwithstanding this connection, the industrial state was so radically different from the military as to require an intermediate term; and in the same way that, in the spiritual evolution, an intermediate term was required between the theological and the positive spirit. In both cases, the middle phase was fluctuating and equivocal. We shall see hereafter that, in the temporal case, it consisted, first, in a substitution of a defensive for an offensive military organization, and afterward in an involuntary general subordination, more and more marked, of the military spirit to the instinct of production. This transitory phase being the one in which we live, its proper nature, vague as it is, can be estimated by direct intuition.

Such is the temporal evolution, briefly surveyed in its three periods. No philosophical mind can help being struck by the analogy between this indisputable progression and our primary law of succession of the three states of the human mind. But our sociological demonstration requires that we should establish the connection between them by exhibiting the natural affinity which has always existed, first between the theological and the military spirit, and afterward between the scientific and the industrial; and, consequently, between the two transient functions of the metaphysicians and the legists. This elucidation will impart the last degree of precision and consistency to my demonstration, and will thus establish it as the rational basis of the entire historical analysis which will follow.

Affinity between the theological and the military *régime.*

The occasional rivalry between the theological power and the military, which history presents, has sometimes disguised their radical affinity, even in the eyes of philosophers. But, if we consider, there can be no real rivalry but among the different elements of the same political system, in consequence of that spontaneous emulation which, in all cases of human concurrence, must become more earnest and extensive as the end is more important and indirect, and therefore the means more distinct and independent, without the participation, voluntary or instinctive, being thereby prevented. When two powers, equally energetic, rise, increase, and decline together, notwithstanding the difference of their natures, we may be assured that they belong to the same *régime*, whatever may be their habitual conflicts. Conflict indicates radical incompatibility only when it takes place between two elements employed in analogous functions, and when the gradual growth of the one coincides with the continuous decline of the other.

As to the present case, it is evident that, in any political system, there must be an incessant rivalry between the speculative and the active powers, which, through the imperfection of our nature, must often be inclined to ignore their necessary co-ordination, and to disdain the general limits of their reciprocal attributes. Notwithstanding the social affinity between science and industry, we must look for similar conflict between them hereafter, in proportion to the political ascendency which they will obtain together. We see signs of it already in the intellectual and moral antipathy of Science to the natural inferiority of these labors of Industry which yet are the means of wealth, and in the instinctive repugnance of Industry to the abstraction which characterizes Science, and to the just pride by which it is animated.

Having despatched these objections, we may now contemplate the strong bond which unites the theological and military powers, and which has in all ages been felt and honored by all enlightened men who have borne a part in either, notwithstanding the passions of political rivalry. It is plain that no military system could arise and endure without the countenance of the theological spirit, which must secure for it the complete and permanent subordination essential to its existence. Each period imposes equal exigences of this sort in its special manner. At the outset, when the narrowness and nearness of the aim required a less absolute submission of mind, social ties were so weak that nothing could have been done but for the religious authority with which military chiefs were naturally invested. In more advanced times the end became so vast and remote, and the participation so indirect, that even long habits of discipline would not have secured the necessary co-operation without the aid of theological convictions occasioning blind and involuntary confidence in military superiors. It was in very ancient times that the military spirit had its great social function to fulfil; and it was in those ancient times that the two powers were usually found concentred in the same chiefs. We must observe also that it was not every spiritual authority whatever that would have sufficiently suited the foundation and consolidation of military government, which, from its nature, required the concurrence of the theological philosophy, and no other: for instance, though natural philosophy has rendered eminent service in modern times to the art of war, the scientific spirit, which encourages habits of rational discussion, is radically incompatible with the military spirit; and we know that the subjection of their art to the principles of science has always been bitterly deplored by the most distinguished soldiers, on the introduction of every change, as a token of the decline of the military system. On this ground, then, the affinity of temporal military powers for spiritual theological powers is sufficiently accounted for. At the first glance we might suppose the converse relation to be less indispensable, since purely theocratic societies have existed, while an exclusively military one has never been known. But a closer examination will always show the necessity of the millitary system to consolidate, and yet more to extend, the theological authority, developed in this way by a continual political application, as the sacerdotal instinct has always been well aware. We shall see again that the theological spirit is as hostile to the expansion of industry as the military. Thus the two elements of the primitive political system have not only a radical affinity, but common antipathies and sympathies, as well as general interests; and it must be needless to enlarge further in this place on the sociological principle of the concurrence of these powers, which my historical analysis will present as constantly engaged in consolidating and correcting each other.

Affinity between the Positive and Industrial spirit.

The latest case of political dualism is even more unquestionable than the earliest, and we are favorably circumstanced for observing it—the two elements not having yet attained their definite ascendency, though their social development is sufficiently marked. When the time arrives for their political rivalry, it may be more difficult than now to exhibit that resemblance in origin and destination, and that conformity of principles and interests, which could not be seriously disputed as long as their common struggle against the old political system acts as a restraint upon their divergencies. The most remarkable feature that we have to contemplate in their case is the aid which each renders to the political triumph of the other, by seconding its own efforts against its chief antagonist. I have already noticed, in another connection, the secret incompatibility between the scientific spirit and the military. There is the same hostility between the industrial spirit, when sufficiently developed, and the theological. The most zealous advocates of the old *régime* are very far removed from the old religious point of view; but we can transport ourselves to it for a moment, and see how the voluntary modification of phenomena by the rules of human wisdom must thence appear as impious as the rational prevision of them, as both suppose invariable laws, finally irreconcilable with all arbitrary will. According to the rigorous though barbarous logic of the least-civilized nations, all human intervention to improve the economy of nature is an injurious attack upon providential government. There is no doubt, in fact, that a strong preponderance of the religious spirit benumbs the industrial, by the exaggerated feelings of a stupid optimism, as has been abundantly clear on many decisive occasions. That this disastrous effect has not been more fatal is owing to priestly sagacity, which has so managed this dangerous power as to educe its civilizing influence, while neutralizing its injurious action by constant and vigilant effort, in a way which I shall presently exhibit. We can not, then, overlook the political influence by which the gradual expansion of human industry must aid the progressive ascendency of the scientific spirit, in its antagonism to the religious; to say nothing of the daily stimulus which industry and science impart to each other, when once strong enough for mutual action. Thus far their office has chiefly been to substitute themselves for the ancient political powers which are yielding up their social influence; and our attention is necessarily drawn chiefly to the aid they have afforded to each other in this operation. But it is easy to perceive what force and what efficacy must reside in their connection, when it shall have assumed the organic character, in which it is at present deficient, and shall proceed to the final reorganization of modern society.

Intermediate *régime*

Now that we have examined the two extreme states, the intermediate dualism requires little notice. The interconnection of the convergent powers, spiritual and temporal, which constitutes the transitory *régime*, is a necessary consequence of all that we have been observing. Indeed, we need but look at the labors of metaphysicians and legists to see what their affinity is, amidst their rivalries; an affinity which stakes the philosophical ascendency of the one class on the political preponderance of the other. We may, then, regard as now complete the necessary explanation required by our fundamental law of human evolution, in order to its direct application to the study of this great phenomenon. That study will be guided by the consideration of the three dualisms which I have established as the only basis of sound historical philosophy. It is worth noticing the conformity of this law of succession, at once intellectual and material, social and political, with the historical order which popular reason has instinctively established by distinguishing the ancient and the modern world, separated and reunited by the Middle Ages. The sociological law which I have propounded may be found to have for its destination to take up a vague empirical notion, hitherto barren, and render it rational and prolific. I hail this spontaneous coincidence, as giving a sanction to my speculative labors; and I claim this confirmation, in virtue of that great aphorism of positive philosophy which I have quoted so often, which enjoins upon all sound scientific theories to start from a point sufficiently accordant with the spontaneous indications of popular reason, of which true science is simply a special prolongation.

The series of views of social dynamics sketched out in this chapter has established the fundamental law of human development, and therefore the bases of historical philosophy. We had before ascertained the spirit and method of that philosophy; and we may now therefore proceed to apply this great sociological conception to the analysis of the history of mankind.

CHAPTER VII.

PREPARATION OF THE HISTORICAL QUESTION.—FIRST THEOLOGICAL PHASE: FETICHISM.—BEGINNING OF THE THEOLOGICAL AND MILITARY SYSTEM.

THE best way of proving that my principle of social development will ultimately regenerate social science, is to show that it affords a perfect interpretation of the past of human society—at least in its principal phases. If, by this method, any conception of its scope and proper application can be obtained, future philosophers can extend the theory to new analyses, and more and more special aspects of human progression. The application which I propose now to enter upon must, however, in order to be brief, be restricted; and the first part of my task is to show what the restrictions must be.

Limitations of the analysis.

The most important of these restrictions, and the one which comprehends all the rest, is, that we must confine our analysis to a single social series; that is, we must study exclusively the development of the most advanced nations, not allowing our attention to be drawn off to other centres of any independent civilization which has, from any cause whatever, been arrested, and left in an imperfect state. It is the selectest part, the vanguard of the human race, that we have to study; the greater part of the white race, or the European nations—even restricting ourselves, at least in regard to modern times, to the nations of Western Europe. When we ascend into the remoter past, it will be in search of the political ancestors of these peoples, whatever their country may be. In short, we are here concerned only with social phenomena which have influenced, more or less, the gradual disclosure of the connected phases that have brought up mankind to its existing state. If Bossuet was guided by literary principle in restricting his historical estimate to one homogeneous and continuous series, it appears to me that he fulfilled not less successfully the philosophical conditions of the inquiry. Those who would produce their whole stock of erudition, and mix up with the review such populations as those of India and China, and others that have not aided the process of development, may reproach Bossuet with his limitations; but not the less is his exposition, in philosophical eyes, truly universal. Unless we proceed in this way, we lose sight of all the political relations arising from the action of the more advanced on the progress of inferior nations. The metaphysical, and even the theological polity seeks to realize its absolute conceptions everywhere, and under all circumstances, by the same empiricism, which disposes civilized men everywhere to transplant into all soils their ideas, customs, and institutions. The consequences are such that practice requires as imperatively as theory that we should concentrate our view upon the most advanced social progression. When we have learned what to look for from the *élite* of humanity, we shall know how the superior portion should intervene for the advantage of the inferior; and we can not understand the fact, or the consequent function, in any other way: for the view of coexisting states of inequality could not help us. Our first limit, then, is that we are to concentrate our sociological analysis on the historical estimate of the most advanced social development.

For this object we want only the best-known facts; and they are so perfectly co-ordinated by the law of the three periods, that the largest phases of social life form a ready and complete elucidation of the law; and when we have to contemplate the more special aspects of society, we have only to apply in a secondary way the corresponding subdivisions of the law to the intermediate social states. Social physiology being thus directly founded, its leading conception will be more and more precisely wrought out by our successors by its application to shorter and shorter intervals, the last perfection of which would be, if it could be reached, that the true filiation of every kind of progress should be traced from generation to generation.

In this department of science, as in every other, the commonest facts are the most important. In our search for the laws of society, we shall find that exceptional events and minute details must be discarded as essentially insignificant, while science lays hold of the most general phenomena which everybody is familiar with, as constituting the basis of ordinary social life. It is true, popular prejudice is against this method of study; in the same way that physics were till lately studied in thunder and volcanoes, and biology in monstrosities: and there is no doubt that a reformation in our ignorant intellectual habits is even more necessary in Sociology than in regard to any of the other sciences.

Abstract treatment of History.

The restrictions that I have proposed are not new, or peculiar to the latest department of study. They appear in all the rest under the form of the distinction between abstract and concrete science. We find it in the division which is made between physics and natural history, the first of which is the appropriate field of positive philosophy. The division does not become less indispensable as phenomena become more complex: and it in fact decides, in the clearest and most precise manner, the true office of historical observation in the rational study of social dynamics. Though, as Bacon observed, the abstract determination of the general laws of individual life rests on facts derived from the history of various living beings, we do not the less carefully separate physiological or anatomical conceptions from their concrete application to the total mode of existence proper to each organism. In the same way we must avoid confounding the abstract research into the laws of social existence with the concrete histories of human societies, the explanation of which can result only from a very advanced knowledge of the whole of these laws. Our employment of history in this inquiry, then, must be essentially abstract. It would, in fact, be history without the names of men, or even of nations, if it were not necessary to avoid all such puerile affectation as there would be in depriving ourselves of the use of names which may elucidate our exposition, or consolidate our thought. The further we look into this branch of science, as well as others, the more we shall find that natural history, essentially synthetic, requires, to become rational, that all elementary orders of phenomena should be considered at once: whereas, natural philosophy must be analytical, in order to discover the laws which correspond to each of the general categories. Thus the natural history of humanity involves the history of the globe and all its conditions, physical, chemical, and everything else: while the philosophy of society can not even exist till the entire system of preceding sciences is formed, and the whole mass of historical information offered as material for its analysis. The function of Sociology is to derive from this mass of unconnected material information which, by the principles of the biological theory of Man, may yield the laws of social life; each portion of this material being carefully prepared by stripping off from it whatever is peculiar or irrelevant—all circumstances, for instance, of climate, locality, etc.—in order to transfer it from the concrete to the abstract. This is merely what is done by astronomers, physicists, chemists, and biologists, in regard to the phenomena they have to treat; but the complexity of social phenomena will always render the process more delicate and difficult in their case, even when the positivity of the science shall be universally admitted. As for the reaction of this scientific treatment on History itself, I hope that the following chapters will show that it sets up a series of immutable landmarks throughout the whole past of human experience; that these landmarks afford direction and a rallying-point to all subsequent observations; and that they become more frequent as we descend to modern times, and social progression is accelerated.

Abstract inquiry into laws.

As the abstract history of humanity must be separated from the concrete, so must the abstract inquiry into the laws of society be separated from questions of concrete Sociology. Science is not yet advanced enough for this last. For instance, geological considerations must enter into such concrete inquiry, and we have but little positive knowledge of geology: and the same is true of questions of climate, race, etc., which never can become positively understood till we can apply to them the sociological laws which we must attain through the abstract part of the study. The institution of social dynamics would be in fact impossible, if we did not defer to a future time the formation of concrete sociology; and, ready as we are to pursue this course in regard to other sciences, there can be no reason why we should resist it here. —As an instance of this necessity, let us take the most important sociological inquiry that presents itself,—the question of the scene and agent of the chief progression of the race. Why is Europe the scene, and why is the white race the agent, of the highest civilization? This question must have often excited the curiosity of philosophers and statesmen; yet it must remain premature, and incapable of settlement by any ingenuity, till the fundamental laws of social development are ascertained by the abstract research. No doubt, we are beginning to see, in the organization of the whites, and especially in their cerebral constitution, some positive germs of superiority; though even on this naturalists are not agreed: and again, we observe certain physical, chemical, and biological conditions which must have contributed to render European countries peculiarly fit to be the scene of high civilization: but if a trained philosophical mind were to collect and arrange all the material for a judgment that we possess, its insufficiency would be immediately apparent. It is not that the material is scanty or imperfect. The deficiency is of a sociological theory which may reveal the scope and bearing of every view, and direct all reasoning to which it may give rise: and in the absence of such a theory, we can never know that we have assembled all the requisites essential to a rational decision. In every other case is the postponement of the concrete study as necessary as in this: and if the novelty and difficulty of my creative task should compel me occasionally to desert my own logical precept, the warning I have now given will enable the reader to rectify any errors into which I may lapse.

Coexistence of successive states.

One more preliminary consideration remains. We must determine more precisely than I have yet done the regular mode of definition of the successive periods which we are about to examine. The law of evolution, no doubt, connects the chief historical phases with the corresponding one of the three periods: but there is an uncertainty of a secondary kind for which I must provide a solution. It arises out of the unequal progression of the different orders of ideas, which occasions the coexistence, for instance, of the metaphysical state of some intellectual category with the theological state of a later category, less general and less advanced,—or with the positive state of a former category, less complex and more advanced. The apparent confusion thus produced must occasion perplexing doubts in minds which are not in possession of the explanation about the true philosophical character of the corresponding times: but the hesitation may be obviated or relieved by its being settled what intellectual category is to decide the speculative state of any period. On all accounts, the decision must be grounded on the most complex and special; that is, the category of moral and social ideas,—not only on account of their eminent importance, but from their position at the extremity of the encyclopedical scale. The intellectual character of each period is governed by that order of speculations; and it is not till any new mental *régime* has reached that category that the corresponding evolution can be regarded as realized, beyond all danger of a return to the prior state. Till then, the more rapid advance of the more general categories can only establish in each phase the germs of the next, without its own character being much affected; or can, at most, introduce subdivisions into the period. For instance, the theological period must be regarded as still subsisting, as long as moral and political ideas retain a theological character, though other intellectual categories may have passed into the metaphysical state, and some few of the simplest into the positive. Under this method of proceeding, the essential aspect of each period will remain as marked as possible, while freely admitting of the preparation of the following. We may now proceed to a direct examination of the successive periods, estimating the rational character of each, on the one hand; and, on the other, exhibiting its filiation to the preceding, and its tendency to prepare for the following; so as to realize by degrees the positive concatenation whose principle has been already established.

Fetichism.

The theological period of humanity could begin no otherwise than by a complete and usually very durable state of pure Fetichism, which allowed free exercise to that tendency of our nature by which Man conceives of all external bodies as animated by a life analogous to his own, with differences of mere intensity. This primitive character of human speculation is established by the biological theory of Man in the *à-priori* way; and in the opposite way, by all the precise information that we can obtain of the earliest social period; and again, the study of individual development confirms the analysis of the collective. Some philosophers set out in the inquiry, as a matter of course, with the supposition that polytheism was the first stage; and some have been so perverse as to place monotheism furthest back, and fetichism as a corruption of polytheism: but such inversions are inconsistent with both the laws and the facts of human history.

Starting-point of the human race.

The real starting-point is, in fact, much humbler than is commonly supposed, Man having everywhere begun by being a fetich-worshipper and a cannibal. Instead of indulging our horror and disgust of such a state of things by denying it, we should admit a collective pride in that human progressiveness which has brought us into our present state of comparative exaltation, while a being less nobly endowed than Man would have vegetated to this hour in his original wretched condition. Another supposition involves an error less grave, but still requiring notice. Some philosophers suppose a state prior even to fetichism; a state in which the human species was altogether material, and incapable of any speculation whatever;—in that lowest condition in which they now conclude the natives of Tierra del Fuego and some of the Pacific Islanders to be. If this were true, there must have been a time when intellectual wants did not exist in Man: and we must suppose a moment when they began to exist, without any prior manifestation;—a notion which is in direct contradiction to biological principles, which show that the human organism, in all times and places, has manifested the same essential needs, differing only in their degree of development and corresponding mode of satisfaction. This is proof enough of the error of the supposition: and all our observation of the lowest idiotcy and madness in which Man appears to be debased below the higher brutes, assures us that a certain degree of speculative activity exists, which obtains satisfaction in a gross fetichism. The error arises from the want of knowing what to look for; and hence, the absence of all theological ideas is hastily concluded wherever there is no organized worship or distinct priesthood. Now, we shall see presently that fetichism may obtain a considerable development, even to the point of star-worship, before it demands a real priesthood; and when arrived at star-worship, it is on the threshold of polytheism. The error is natural enough, and excusable in inquirers who are unfurnished with a positive theory which may obviate or correct any vicious interpretation of facts.

On the ground of this hypothesis, it is said that Man must have begun like the lower animals. The fact is so,—allowing for superiority of organization; but perhaps we may find in the defects of the inference a misapprehension of the mental state of the lower animals themselves. Several species of animals afford clear evidence of speculative activity: and those which are endowed with it certainly attain a kind of gross fetichism, as Man does,—supposing external bodies, even the most inert, to be animated by passion and will, more or less analogous to the personal impressions of the spectator. The difference in the case is that Man has ability to raise himself out of this primitive darkness, and that the brutes have not,—except some few select animals, in which a beginning to polytheism may be observed,—obtained, no doubt, by association with Man. If, for instance, we exhibit a watch to a child or a savage, on the one hand, and a dog or a monkey, on the other, there will be no great difference in their way of regarding the new object, further than their form of expression:—each will suppose it a sort of animal, exercising its own tastes and inclinations: and in this they will hold a common fetichism,—out of which the one may rise, while the other can not. And thus the allegation about the starting-point of the human species turns out to be a confirmation of our proposition, instead of being in any way inconsistent with it.

It is so difficult to us to conceive of any but a metaphysical theology, that we are apt to fall into perpetual mistakes in contemplating this, its gross origin. Fetichism has even been usually confounded with polytheism, when the latter has been called Idolatry,—a term which applies only to the former; and the priests of Jupiter and Minerva would doubtless have repelled the trite reproach of the adoration of images as justly as Catholic priests do now, when subject to the same charge from Protestants. But, though we are too distant from fetichism to form a just conception of it, each one of us may find in his own earliest experience a more or less faithful represention of it. The celebrated phrase of Bossuet, applied to the starting-point of the human mind, describes the elementary simplicity of theology:—*Everything was God, except God himself;* and from that moment forward, the number of gods steadily decreased. We may reorganize some features of that state in our own conditions of mind when we are betrayed into searching after the mode of production of phenomena, of whose natural laws we are ignorant. We then instinctively conceive of the production of unknown effects according to the passions and affections of the corresponding being regarded as alive; and this is the philosophical principle of fetichism. A man who smiles at the folly of the savage in taking the watch for an animal may, if wholly ignorant of watch-making, find himself surprised into a state not so far superior, if any unforeseen and inexplicable effects should arise from some unperceived derangement of the mechanism. But for a widely analogous experience, preparing him for such accidents and their interpretation, he could hardly resist the impression that the changes were tokens of the affections or caprices of an imaginary being.

Thus is Fetichism the basis of the theological philosophy,—deifying every substance or phenomenon which attracts the attention of nascent humanity, and remaining traceable through all its transformations to the very last. The Egyptian theocracy, whence that of the Jews was evidently derived, exhibited, in its best days, the regular and protracted coexistence of the three religious periods in the different castes of its sacerdotal hierarchy,—the lowest remaining in mere fetichism, while those above them were in full possession of a marked polytheism, and the highest rank had probably attained an incipient monotheism. Moreover, a direct analysis will disclose to us very marked traces, at all times, of the original fetichism, however it may be involved in metaphysical forms in subtile understandings. The conception among the ancients of the Soul of the universe, the modern notion that the earth is a vast living animal, and, in our own time, the obscure pantheism which is so rife among German metaphysicians, is only fetichism generalized and made systematic, and throwing a cloud of learned words as dust into the eyes of the vulgar. These evidences show that fetichism is no theological aberration, but the source of theology itself,—of that primitive theology which exhibits a complete spontaneousness, and which required from Man in his apathetic state no trouble in creating supernatural agents, but permitted him passively to yield to his propensity to transfer to outward objects the sense of existence which served him for an explanation of his own phenomena, and therefore for an absolute explanation of all out of himself. At first it was only inanimate nature that was the object in its more conspicuous phenomena,—even the negative ones, such as shadows, which no doubt terrified the nascent race as they now alarm individual children and some animals: but the spontaneous theology soon extended to embrace the animal kingdom, producing the express adoration of brutes, when they presented any aspect of mystery: that is, when Man did not find the corresponding equivalent of their qualities in himself,—whether it were the exquisite superiority of the sense of smell, or any other sense in animals, or that their organic susceptibility made them aware, sooner than himself, of atmospheric changes, etc., etc.

Relation of Fetichism to Morals.

That philosophy was as suitable to the moral as to the intellectual state of the infant human race. The preponderance of the affective over the intellectual life, always conspicuous, was in its full strength in the earliest stages of the human mind. The empire of the passions over the reason, favorable to theology at all times, is yet more favorable to fetich theology than to any other. All substances being immediately personified, and endowed with passions, powerful in proportion to the energy of the phenomena, the external world presented to the observer a spectacle of such perfect harmony as has never been seen since: of a harmony which yielded him a satisfaction to which we can not even give a name, from our inability to feel it, however strenuously we may endeavor to carry our minds back into that cradle of humanity. It is easy to see how this exact correspondence between the universe and Man must attach us to fetichism, which, in return, specially protracts the appropriate moral state. In more advanced periods, evidence of this appears when organizations or situations show us any overwhelming action of the affective part of Man's nature. Men who may be said to think naturally with the hinder part of the head, or who find themselves so disposed for the moment, are not preserved even by high intellectual culture from the danger of being plunged by some passion of hope or fear, into the radical fetichism,—personifying, and then deifying, even the most inert objects that can interest their roused sensibilities. From such tendencies in our own day, we may form some idea of the primitive force of such a moral condition, which, being at once complete and normal, was also permanent and universal.

To Language.

The metaphorical constitution of human language is, in my eyes, a remarkable and eternal testimony to the primitive condition of Man. There can be no doubt that the main body of human language has descended from that remotest period, which must probably have endured much longer than any other, from the special slowness of such progress as it could admit of. The common opinion which attributes the use of figurative expressions to a dearth of direct signs is too rational to be admissible with regard to any but a very advanced period. Up to that time, and during the ages which must have mainly influenced the formation or rather the development, of language, the excessive abundance of figures belonged naturally to the prevalent philosophy, which, likening all phenomena to human acts, must introduce as faithful description expressions which must seem metaphorical when that state had passed away in which they were literal. It is an old observation that the tendency diminishes as the human mind expands; and we may remark that the nature of metaphors is gradually transformed with the lapse of time:—in the early ages men transferred to the external world the expressions proper to human acts; whereas now we apply to the phenomena of life terms originally appropriated to inert nature, thus showing that the scientific spirit, which looks from without inward, is more and more influencing human language.

To Intellect.

Looking now to the influence of the primitive theological philosophy on human progression, we observe that fetichism is the most intense form of theology—at least, as regards the individual; that is, the fetich form of that order of ideas is the one which most powerfully influences the mental system. If we are surprised at the number of pagan gods that we are continually meeting with in ancient books, there is no saying how we might be impressed if we could for a moment see the multitude of deities that the pure fetich-worshipper must live in the midst of. And again, the primitive man could see and know nothing but through his theological conceptions, except some very few practical notions of natural phenomena, furnished by experience, and little superior to the knowledge obtained by the higher animals by the same means. In no other religious period could theological ideas be so completely adherent to the sensations, which were incessantly presenting those ideas; so that it was almost impossible for the reason to abstract them in any degree, or for a single moment. It does not follow that the social influence of this form of theology was at all in proportion to its effect on individuals. On the contrary, the political influence of the theological philosophy will be seen, as we proceed, to strengthen as it becomes more abstract in the human mind.

It is not difficult to perceive why fetichism was a feeble instrument of civilization, notwithstanding its wide intellectual dominion; and this will disclose to us what its social influence really was.

To Society.

In the first place, sacerdotal authority is indispensable to render available the civilizing quality of theological philosophy. All doctrine must have special organs, to direct its social application; and the necessity is strongest in the case of religious doctrine, on account of its indefinite character, which compels a permanent exercise of active discipline, to keep the vagueness and indefiniteness within bounds. The experience of the last three centuries shows us how, when sacerdotal authority is broken up, religious ideas become a source of discord instead of union: and this may give us some notion of the small social influence of a theology which anticipated all priesthoods, though it might be the first concern of every member of that infant society. Why fetichism admitted of no priesthood, properly so called, is obvious. Its gods were individual; and each resided fixedly in a particular object; whereas, the gods of polytheism are more general by their nature, and have a more extended dominion and residence. The fetich gods had little power to unite men, or to govern them. Though there were certainly fetiches of the tribe, and even of the nation, the greater number were domestic, or even personal; and such deities could afford little assistance to the development of common ideas. And again, the residence of each deity in a material object left nothing for a priesthood to do, and therefore gave no occasion for the rise of a distinct speculative class. The worship, incessant and pervading as it was, when every act of a man's life had its religious aspect, was of a kind that required every man to be his own priest, free from intervention between himself and gods that were constantly accessible. It was the subsequent polytheistic belief in gods that were invisible, more or less general, and distinct from the substances which they ruled, that originated and developed a real priesthood, enjoying high social influence, in its character of mediator between the worshipper and his deity. In the most triumphant periods of Greek and Roman polytheism, we meet with evidences of the contrasted character of the two theological phases, in the Lares and Penates, the domestic gods which had survived the fetich multitude, and which were served, not by any priest, but by each believer; or, at most, by the head of the family, as their spontaneous priest.

The beginning of a priesthood may, however, be discerned in the professions of soothsayers, conjurers, etc., which exist among the fetich tribes of Africa: but a close inquiry into their state, as into that of the first societies of men, will show that, in such cases, fetichism has reached its highest elevation, and become star-worship. This astrolatry is the introduction to polytheism; and it has qualities which instigate the development of a genuine priesthood. There is a character of generality about the stars which fits them to be common fetiches: and sociological analysis shows us that this was in fact their destination among populations of any extent. And again, when their inaccessible position was understood (which was not so soon as is commonly thought) the need of special intermediaries began to be felt. These two circumstances, the superior generality and the inaccessible position of the stars, are the reasons why the adoration of them, without changing the character of the universal fetichism, determined the formation of an organized worship and a distinct priesthood: and thus the advent of astrolatry was not only a symptom, but a powerful means of social progress in its day, though, from its extreme and mischievous protraction, we are apt to condemn it as universally a principle of human degradation. It must have been long, however, before star-worship obtained a marked ascendency over other branches of fetichism, so as to impart a character of real astrolatry to the whole religion. The human mind was long engrossed with what lay nearest; and the stars held no prominent place in comparison with many terrestrial objects, as, for instance, meteorological effects, which indeed furnished the attributes of supernatu-

Astrolatry.

ral power through nearly the whole of the theological period. While magicians could control the moon and stars, no one supposed they could have anything to do with the government of the thunder. A long series of gradual modifications in human conceptions was therefore necessary to invert the primitive order, and place the stars at the head of natural bodies, while still subordinated to the earth and Man, according to the spirit of theological philosophy at its highest perfection. But, it was only when fetichism rose to the elevation of astrolatry that it could exercise any great social influence, for the reasons thus given. And this is the rational explanation of the singular characteristic of the theological spirit—that its greater intellectual extension is coincident with its smaller social influence. Thus, not only does fetichism share the common condition of all philosophies, that of not extending to moral and social considerations till it has embraced all simpler speculations, but there are special reasons for the retardation of the time when it can acquire any political consistency, notwithstanding its vast preparatory intellectual extension. The further we proceed in our review of the social operation of the theological spirit, the more we shall perceive how great is the mistake of supposing that religious belief is the only basis of human association, to the exclusion of all other orders of common conceptions. We have now seen that the political attribute did not disclose itself in the period of the greatest mental prevalence of the religious system: and we shall presently find that polytheism, and yet more monotheism, exhibits the necessary connection between the intellectual decline of the theological spirit and the perfect realization of its civilizing faculty: and this will confirm our conclusion that this social destination could be attributed to it only provisionally, while awaiting the advent of more direct and more permanent principles.—If, however, fetichism is not adapted to the development of the theological polity, its social influence has nevertheless been very extensive, as may be easily shown.

Relation to human knowledge.

In a purely philosophical view,—that is, in regard to its function of directing human speculation,—this earliest form of religious belief manifests in the smallest possible degree the theological quality of attacking the original torpor of the human faculties, by furnishing some aliment to our conceptions, and some bond between them. Having done this, fetichism obstructs all advance in genuine knowledge. It is in this form, above all others, that the religious spirit is most directly opposed to the scientific, with regard to the simplest phenomena; and all idea of natural laws is out of the question when every object is a divinity with a will of its own. At this period of intellectual infancy, imaginary facts wholly overwhelm real ones; or rather, there is no phenomenon which can be distinctly seen in its genuine aspect. The mind is in a state of vague pre-occupation with regard to the external world, which, universal and natural as it is, is not the less a kind of permanent hallucination, proceeding from such a preponderance of the affective over the intellectual life, that the most absurd beliefs impair all direct observation of natural phenomena. We are too apt to treat as imposture exceptional sensations which we have long ceased to be able to understand, but which have always been well known to magicians and fortunetellers in the stage of fetichism; but, if we try, we may picture to ourselves how it is that, in the absence of all conception of natural laws, nothing can appear monstrous, and Man is pretty sure to see what he is disposed to see, by illusions which appear to me strongly analogous to those which are experienced by brutes, through their gross fetichism. However familiar we may now be with the conception of the regularity of natural events, and however this conception may be now the basis of our whole mental system, it is certainly not an innate idea, as each of us can almost assign the very date of its formation in his own mind. Setting ourselves back to a time before its existence among men, we can not wonder at the hallucinations produced by an intellectual activity so at the mercy of the passions, or of natural stimulants affecting the human frame; and our surprise is rather that the radical integrity of the mind of Man should have restrained as far as it did the tendency to illusion which was encouraged by the only theories then possible.

To the fine arts.

The influence of fetichism was less oppressive in regard to the fine arts. It is evident that a philosophy which endowed the whole universe with life must favor the expansion of imagination, which was then supreme among the faculties. Thus, it is certain that the origin of all the fine arts, not excepting poetry, is to be referred to the fetich period. When I treat of the relation of polytheism to the fine arts, I shall have occasion to glance at that of fetichism also; and I therefore leave it now; observing only that the fact to be shown is that, in social as in individual life, the rise and expansion of human faculties begins with the faculties of expression, so as gradually to lead on the evolution of the superior and less marked faculties, in accordance with the connection established among them by our organization.

To industry.

As to the industrial development of the race, it is certain that Man began his conquests over external nature in the fetich period. We do not give their due to those primitive times when we forget that it was then that men learned to associate with tamed animals, and to use fire, and to employ mechanical forces, and even to affect some kind of commerce by the nascent institution of a currency. In short, the germs of almost all the arts of life are found in that period. Moreover, Man's activity prepared the ground for the whole subsequent evolution of the race by the exercise of his destructive propensities, then in their utmost strength. The chase not only brought separate families into association when nothing else could have done it, but it cleared the scene of social operations from the encumbrance of an inconvenient multitude of brutes. So great was the destruction, that it is now believed to have concurred with some geological causes in obliterating certain races of animals, and especially some of the largest: in the same way that the superfluous vegetation is believed to have been got rid of by the devastation attending a pastoral mode of life. It is not easy however to settle how much of the industrial advance of the period is to be attributed to its fetichism. At the first glance, it might seem that the direct consecration of external objects must forbid Man to modify the world around him: and it is certain that too long a protraction of fetichism could not but have that effect, if the human mind were always or ever thoroughly consistent, and if there were no conflict between beliefs and instincts, in which the first must give way. But there is to be considered, besides, the theological quality which is so favorable to the incitement of human activity in the absence of all knowledge of natural laws,—the assurance given to Man that he is supreme in Nature. Though his supremacy is unavailing without the intervention of divine agents, the constant sense of this supreme protection can not but be the best support to human energy at a period when Man is surrounded by immense obstacles, which he would not otherwise venture to attack. Up to a very recent date in human history, when the knowledge of natural laws had become a sufficient groundwork for wise and bold action, the imperfect and precarious theological stimulus continued to act. Its function was all the more appropriate to fetichism, that it offered the hope of almost unlimited empire by an active use of religious resources. The more we contemplate those primitive ages, the more clearly we shall see that the great move was rousing the human mind from animal torpor; and it would have been extremely difficult, physically and morally, if the theological philosophy, in the form of fetichism, had not opened the only possible issue. When we examine, from the right point of view, the characteristic illusions of that age about controlling the courses of the stars, lulling or exciting storms, etc., we are less disposed to an unphilosophical contempt than to mark in these facts the first symptoms of the awakening of human intelligence and activity.

Political influence.

As to its social influence, fetichism effected great things for the race, though less than the subsequent forms of the theological spirit. We are apt to underrate these services, because the most religious persons of our own time are unable to do justice to the effects of a belief which is extinct. It is only the positive philosophy which enables us to estimate the share borne by the religious spirit in the social, as well as the intellectual progression of the human race. Now, it is plain that moral efforts must, from our organizations, be almost always in conflict, more or less, with the strongest impulses of our nature; and what but the theological spirit could afford a ground for social discipline at a time when foresight, collective and individual, was far too restricted to sustain any influences of rationality? Even at more advanced periods, institutions which are justified by reason, remain long under theological tutelage before they can be freely committed to their true sanctions; as, for instance, when sanitary precepts are diffused and established by religious prescription. An irresistible induction shows us the necessity of a similar consecration of social changes in which we are at present least disposed to look for it. We should not, for instance, suspect any religious influence to be concerned in the institution of property; yet there are some aspects of society, in which we find it; as, for instance, in the famous *Taboo* of the Pacific Islands, which I regard as a valuable trace of the participation of theology in that first consolidation of territorial property which takes place when hunting or pastoral tribes pass into the agricultural stage. It seems probable, too, that religious influences contributed to establish, and yet more to regulate, the permanent use of clothing, which is regarded as one of the chief marks of nascent civilization, both because it stimulates industrial aptitudes and because its moral operation is good in encouraging Man to improve his own nature by giving reason control over the propensities.

It is a great and injurious mistake to conceive of this theological influence as an artifice applied by the more enlightened men to the government of the less. We are strangely apt to ascribe eminent political ability to dissimulation and hypocrisy; but it is happily rendered incontestable, by all experience and all study, that no man of superior endowments has ever exercised any great influence over his fellows without being first, for his own part, thoroughly convinced. It is not only that there must be a sufficient harmony of feeling and inclinations between himself and them, but his faculties would be paralyzed by the effort to guide his thoughts in the two opposite ways,—the real and the affected,—either of which would separately be as much as he could manage. If theological theories entered into the simplest speculations of men, in the age of fetichism, they must have governed social and political meditations, the complexity of which rendered religious resources peculiarly necessary. The legislators of that age must have been as sincere in their theological conceptions of society as of everything else; and the dreadful practical extravagances into which they too often fell under that guidance are unquestionable evidence of their general sincerity. We must consider, too, that the earliest theological polity naturally afforded suggestions which were coincident with corresponding social needs. The coincidence arose partly from that general property of all religious phases,—the vagueness of all faiths, which adapts them to be modified by all political exigencies, and thus to appear to sanction a suggestion when they merely respond to a want; and partly from the fact, special in each case, that the beliefs of any society must be mainly determined by the existing modifications of that society; so that opinions must necessarily present certain attributes in special harmony with corresponding social circumstances; and without this they could not retain their influence. By the first property an organization under a priesthood was rendered necessary, to prevent opin ions so capable of abuse from being committed to the vulgar; and by the second, theological theories could not only consecrate all valuable suggestions, but could frequently produce some which were suitable to the contemporary social state. The first corresponds to what is vague and uncontrollable in each religious system; and the other to what is definite and susceptible of regulation; and the two supply each other's deficiencies. As belief becomes simplified and organized, its social influence diminishes under the first aspect, on account of the restriction on speculation; but it is ever increasing under the second aspect, as we shall presently see, permitting superior men to make the utmost use of the civilizing virtue of this primitive philosophy. It is clear that the first of these modes of social action of any theology must prevail eminently in fetichism; and this agrees with our observation of the absence or imperfection of any religious organization; but this fact renders all analysis inextricable, from the difficulty of discerning how much of the religious element was incorporated with the intricate web of a life which our familiar conceptions are so little adapted to unravel. We can only verify by some decisive examples the necessary reality of our theory; a thing which is easily done. As to the second mode, though it operated little during the fetich period, its precise nature enables us to obtain a better hold of it. An example or two will show its effect on the social progress of the race.

Institution of Agriculture.

All philosophers are agreed about the supreme importance of the institution of agricultural life, without which no further human progress would have been possible; but all do not see how religion was concerned in the transition. War, which is the chief temporal instrument of early civilization, has no important social influence till the nomade condition is left behind. The fierce conflicts of hunting, and even of pastoral tribes, are like those of carnivorous animals, and only exercise activity and prepare for progress without producing immediate political results. The importance of subjecting Man to a fixed residence is thus obvious enough, on the one hand, and, on the other, the difficulty attending a change so little compatible in many ways with the character of infant humanity. There can be no doubt that a wandering life was natural to primitive Man, as we see it to be now to individuals below the reach of culture. This show us how the intervention of spiritual influences may have been necessary to so great a change. It is usual to suppose that the condensation of numbers, as the race increased, would compel the tillage of the soil, as it had before compelled the keeping of flocks. But the explanation, though true as far as it goes, is insufficient; for, as we have seen before, want does not produce faculty. No social exigency will find its satisfaction if Man is not already disposed to provide it; and all experience shows that men will, in the most urgent cases, rather palliate each suffering as it arises, than resolve on a total change of condition which is repugnant to their nature. We know by observation what dreadful expedients men would adopt to reduce the excess of population, rather than exchange a nomade for an agricultural life, before their intellectual and moral nature was duly prepared for it. The progression of the human being therefore caused the change, though the precise date of its accomplishment must depend on external requirements; and above all, on the numbers needing food. Now, as agricultural life was certainly instituted before fetichism passed away, it is clear that there must be in fetichism something favorable to the change, though we may not know precisely what it was. But I have no doubt about the essential principle. The worship of the external world must be especially directed to the objects which are nearest and commonest; and this must tend to develop the originally feeble affection of men for their native soil. The moving lamentations of vanquished warriors for their tutelary gods were not about Jupiter, Minerva, or other abstract and general deities, whom they could find everywhere, but for their domestic gods; that is, pure fetiches. These were the special divinities whom the captives wept to leave behind, almost as bitterly as the tombs of their fathers, which were also involved in the universal fetichism. Among nations which had reached polytheism before becoming agricultural, the religious influence necessary to the change was chiefly due, no doubt, to the remains of fetichism, which held a conspicuous place in polytheism, up to a very advanced period. Such an influence then is an essential property of the first theological phase; and it would not have been strong enough in the subsequent religions if the great material change had not by that time been so well established on other grounds as to be able to relinquish the original one which was passing away. The reaction of the change upon theology is, at the same time, worthy of notice. It was then that fetichism assumed that highest form,—that of star-worship,—which was the transition stage to polytheism. It is plain that the settled abode of agricultural peoples must fix their speculative attention upon the heavenly bodies, while their labors remarkably disclosed the influences of the sky: whereas, the only astronomical observations to be expected of a wandering tribe are of the polar star which guides their nocturnal course. Thus there is a double relation between the development of fetichism and the final establishment of agricultural life.

Protection to products.

Another instance of the influence of fetichism on social progress is its occasioning the systematic preservation of serviceable animals, and also of vegetables. It has been shown that the first action of Man on the external world must be in the form of devastation; and his destructive propensities do their work in clearing the field for future operations. A propensity so marked among men as rude as they were vehement threatened the safety of all races, before the utility of any was known. The most valuable organic species were the most exposed; and they must almost inevitably have perished if the first intellectual and moral advance of the human race had not intervened to restrain the tendency to indiscriminate destruction. Fetichism performed this office, not only by introducing agricultural life, but directly; and if it was done by a method which afterward became excessively debased—the express worship of animals, it may be asked how else the thing could have been done. Whatever evils belonged afterward to fetichism, it should be remembered how admirably it was adapted to preserve the most valuable animals and vegetables, and indeed all material objects requiring special protection. Polytheism rendered the same service, by placing everything under the care of some deity or other; but this was a less direct method than that of fetichism, and would not have sufficed in the first instance. No provision of the kind is to be found in monotheism; but neither is it so necessary in the more advanced stage of human progress to which it is adapted: yet the want of regular discipline in this order of relations is found to be a defect to this day, and one which is only imperfectly repaired by purely temporal measures. There can be no doubt that the moral effect of Man's care of animals contributed largely to humanize him. His carnivorous constitution is one of the chief limitations of his pacific capabilities, favorable as is the growing subdivision of employments to the milder inclinations of the majority of society; and, honorable as is the Utopia of Pythagoras, imagined in an age when the destructive tendency prevailed in the highest portion of society, it is not the less opposed to Man's nature and destiny, which oblige him to increase in all directions his natural ascendency over the whole of the animal kingdom. On this account, and for the regulation of this power, laws are essential, as in every other case of power possessed; and fetichism must be regarded as having first indicated, in the only way then possible, an exalted kind of human institution, for the regulation of the general political relations of all,—those of Man toward the external world, and especially the animal part of it. The selfishness of kind could not prevail among these relations without serious danger; and it must become moderate in proportion as the organisms rise to an increasing resemblance to our own. When the positive philosophy shall regulate these relations, it will be by constituting a special department of external nature, in regard to which a familiar knowledge of our interest in the zoological scale will have trained us in our duty to all living beings.

Such were, as nearly as we can estimate, the social influences of fetichism. We must now observe how it passed into polytheism.

Transition to Polytheism.

There can be no doubt of the direct derivation of polytheism from fetichism, at all times and in all places. The analysis of individual development, and the investigation of the corresponding degrees of the social scale, alike disclose this constant succession. The study of the highest antiquity, when illustrated by sound sociological theories, verifies the same fact. In most theogonies the prior existence of fetichism is necessary to the formation of the gods of polytheism. The Greek gods that issued from the Ocean and the Earth, issued from the two principal fetiches; and we have seen how, in its maturity, polytheism incorporates strong remains of fetichism. Speculatively regarded, this transformation of the religious spirit is perhaps the most radical that it has ever undergone, though we are unable, through its remoteness, to appreciate with any steadiness its extent and difficulty. From the comparative nearness and social importance of the transition to monotheism, we naturally exaggerate its relative importance; but, in truth, the interval to be passed was much narrower in the later case than in the earlier. If we reflect that fetichism supposed matter to be, in all forms, actually alive, while polytheism declared it to be nearly inert, and passively subject to the arbitrary will of a divine agent, it seems hardly imaginable how such a transition of views could be gradually made. Both are equally remote from the positive view,—that of the operation of natural laws; but they are no less opposed to each other, except in the one point of some express will being the cause of every incident: and thus it is a matter of the highest philosophical interest to ascertain the spontaneous mode of this memorable transition.

The intervention of the scientific spirit has only recently been direct and explicit; but not the less has it been concerned in all the successive modifications of the religious spirit. If Man had been no more capable than monkeys and carnivorous animals of comparing, abstracting, and generalizing, he would have remained for ever in the rude fetichism which their imperfect organization forbids their surmounting. Man, however, can perceive likeness between phenomena, and observe their succession: and when these characteristic faculties had once found aliment and guidance under the first theological instigation, they gathered strength perpetually, and by their exercise reduced, more and more rapidly, the influence of the religious philosophy by which they had been cherished. The first general result of the rise of this spirit of observation and induction seems to me to have been the passage from fetichism to polytheism, beginning, as all such changes do, with the highest order of minds, and reaching the multitude at last. To understand this, we must bear in mind that, as all fetich faith relates to some single and determinate object, the belief is of an individual and concrete nature. This quality suits well with the particular and unconnected character of the rudely-material observations proper to an infant state of the human mind: so that the exact accordance between the conception and the investigation that is found wherever our understandings are at work, is evident in the present case. The expansion of the spirit of observation caused by the first theory, imperfect as it was, must destroy the balance which, at length, can not be maintained at all but by some modification of the original philosophy. Thus the great revolution which carried men on from fetichism to polytheism is due to the same mental causes, though they may not be so conspicuous, that now produce all scientific revolutions,—which always arise out of a discordance between facts and principles. Thus did the growing generalization of human observations necessitate the same process in regard to the corresponding theological conceptions, and occasion the transformation of fetichism into simple polytheism; for the difference between the divinities of the two systems is the essential one that the gods, properly so called, have, from their indeterminate residence, a more general and abstract character. Each undertakes a special order of phenomena, but in a great number of bodies at the same time; so that each rules a department of some extent; whereas the fetich is inseparable from the one object in which it resides. When certain phenomena appeared alike in various substances, the corresponding fetiches must have formed a group, and at length coalesced into one principal one, which thus became a god; that is, an ideal and usually invisible agent, whose residence is no longer rigorously fixed. Thus, when the oaks of a forest, in their likeness to each other, suggested certain general phenomena, the abstract being in whom so many fetiches coalesced was no fetich, but the god of the forest. Thus, the intellectual transition from fetichism to polytheism is neither more nor less than the ascendency of specific over individual ideas, in the second stage of human childhood, social as well as personal. As every essential disposition is, on our principles, inherent in humanity from the beginning, this process must have already taken place, in certain cases; and the transition was thus, no doubt, much facilitated; as it was only necessary to extend and imitate what had already been done. Polytheism itself may have been primitive in certain cases, where the individual had a strong natural tendency to abstraction, while his contemporaries, being more impressible than reasonable, were more struck by differences than resemblances. As this exceptional condition does not indicate any general superiority, and the cases must have been few and restricted, my theory is not affected by them. They are interesting to us only as showing how the human mind was subjected to its first great philosophical transition, and carried through it. Thus it is that the purely theological nature of the primitive philosophy was preserved, in the conception that phenomena were governed by Will and not by laws; while, again, it was profoundly modified by the view of matter being no longer alive but inert, and obtaining all its activity from an imaginary external being. The intellectual and social consequences of the change will appear hereafter. The remark that occurs in this place is that the decline of the mental influence of the religious spirit, while its political influence is rising, may be distinctly perceived at this stage. When each individual thing lost its character of essential life and divineness, it became accessible to the scientific spirit, which might be humble enough in its operation, but was no longer excluded by theological intervention. The change is evidenced by the corresponding steady diminution of the number of divinities, while their nature was becoming more abstract and their dominion more extended. Each god took the place of a troop of fetiches, which were thenceforth permitted, or reduced, to serve as his escort. We shall hereafter recognise the same process, in the succession of monotheism to polytheism.

The particular issue by which the transition was effected is easily found, when we consider that it must be through the phenomenon which appears the most general and abstract, and the most universal in its influence. The stars answer to this description, when once their isolated and inaccessible position had fixed men's attention, in preference to the nearer objects which had at first engrossed it. The difference in conception between a fetich and a god must be smaller in the case of a star than of any other body; and it was this which made astrolatry, as I observed before, the natural intermediary state between the two first theological phases. Each sidereal fetich, powerful and remote, was scarcely distinguishable from a god; and especially in an age when men did not trouble themselves with nice distinctions. The only thing necessary to get rid of the individual and concrete character altogether, was to liberate the divinity from his imprisonment in one place and function, and to connect him by some real or apparent analogy with more general functions; thus making him a god, with a star for his preferred abode. This last transformation was so little necessary that, throughout nearly the whole polytheistic period, it was only the planets that, on account of their special variations, were subjected to it. The fixed stars remained true fetiches till they were included with everything in the universal monotheism.

The Metaphysical spirit traceable.

In order to complete our estimate of this part of the human evolution, in which all the principles of subsequent progress must be implicated, I must point out the manifestations of the metaphysical spirit which here present themselves. If the theological philosophy is modified by the scientific spirit, this is done only through the metaphysical spirit, which rises with the decline of the theological, till the positive prevails over them both. The more recent dominion of the metaphysical spirit may be the most engrossing to us; but perhaps its operation when it was a mere gradation of the theological philosophy might appear to be of higher importance, if we could estimate the change wrought by it, and were in possession of any precise evidence. When bodies ceased to be divinely alive by their own nature, they must have some abstract property which rendered them fit to receive the action of the supernatural agent—an action which could not be immediate when the agent had a wider influence and an unfixed abode. Again, when a group of fetiches yield up their common attributes to a single god, and that god is regarded as living, in spite of his abstract origin, the conception is metaphysical in its whole character—recognising, as it does, personified abstractions. For the universal characteristic of the metaphysical state, as a transitional condition of the understanding, is a radical confusion between the abstract and the concrete point of view, alternately assumed to modify theological conceptions; now to render abstract what was before concrete, when each generalization is accomplished, and now to prepare for a new concentration the conception of more general existences, which was hitherto only abstract. Such is the operation of the metaphysical spirit on the theological philosophy, whose fictions had offered the only intelligible ground to human understanding, while all that it could do was to transfer to everything out of itself its own sense of active existence. Distinct from every substance, though inseparable from it, the metaphysical entity is more subtile and less definite than the corresponding supernatural action from which it emanates; and hence its aptitude to effect transitions which are invariably a decline, in an intellectual sense, of the theological philosophy. The action is always critical, as it preserves theology while undermining its intellectual basis; and it can appear organic only when it is not too preponderant, and in as far as it contributes to the gradual modification of the theological philosophy, to which, especially in a social view, must be referred whatever may appear to be organic in the metaphysical philosophy. These explanations must at first appear obscure; but the applications we shall have to make of them will render them unquestionable as we proceed. Meantime, it was impossible to defer them, and to neglect the true origin of the metaphysical influence, concerned as it is in the great transition from fetichism to polytheism. Besides the immediate scientific necessity, it is certainly desirable to trace from the cradle of humanity upward, that spontaneous and constant rivalry, first intellectual and then political, between the theological and the metaphysical spirit, which, protracted to the present moment, and necessary till the preparatory revolution is accomplished, is the main cause of our disturbed and conflicting condition.

For the length and complexity of these discussions, their importance must be my excuse. Any irrationality at our starting-point would have vitiated the whole of my historical investigation, while the first stage of human development is little known and confusedly apprehended. The second period will be comparatively easy to present, as it has been better explored, and is less remote in character from our own experience. We learn already, however, the efficacy of the positive philosophy in transferring us to the successive points of view from which the phases of human development may be understood, without losing any of the homogeneousness and independence of its own rational decisions. The value of this property, which is owing to the relative spirit of the new philosophy, will appear more and more as we proceed, and will enable us to comprehend the whole of human history without supposing Man to have ever been in his organization intellectually or morally different from what he is now. If I have inspired any kind of intellectual sympathy in favor of fetichism, which is the lowest aspect of the theological philosophy, it will be easy to show henceforth that the spirit of each period has been not only the most suitable to the corresponding situation, but accordant with the special accomplishment of a determinate process, essential to the development of human nature.

CHAPTER VIII.

SECOND PHASE: POLYTHEISM.—DEVELOPMENT OF THE THEOLOGICAL AND MILITARY SYSTEM.

Monotheism occupies so large a space in the view of modern minds, that it is scarcely possible to form a just estimate of the preceding phases of the theological philosophy; but thinkers who can attain to anything like impartiality in their review of religious periods may satisfy themselves by analysis, and in spite of appearances, that polytheism, regarded in its entire course, is the principal form of the theological system. Noble as we shall find the office of monotheism to have been, we shall remain convinced that polytheism was even more completely and specially adapted to satisfy the social needs of the corresponding period. Moreover, we shall feel that, while every state of the theological philosophy is provisional, polytheism has been the most durable of any; while monotheism, being the nearest to the entire cessation of the theological *régime*, was best fitted to guide civilized humanity through its transitions from the ancient to the modern philosophy.

True sense of Polytheism.

Our method must be to take an abstract view of each of the essential properties of polytheism; and then to examine the various forms of the corresponding *régime*. In doing this, I shall regard Polytheism in the broad popular sense, as it was understood by the multitude and expressed by Homer, and not under any allegorical aspect that erudite and imaginative minds may find in it. It is only under a monotheistic view that the ancient gods can be symbolically regarded. In the infant state of human reason, a great number of gods was required for a great variety of objects, their special attributes being correspondent to the infinite diversity of phenomena; and they were perfectly distinct and independent of each other. This view, prescribed by analysis, is confirmed by all contemporary records, in which I suppose our scholars will hardly look for the hazy symbolism which they themselves propose.

Its operation on the human Mind.

We have seen that, intellectually speaking, fetichism was more closely incorporated with human thought than any other religion; so that the conversion into polytheism was in fact a decline. But the effect of polytheism upon human imagination, and its social efficacy, rendered the second period that of the utmost development of the religious spirit, though its elementary force was already impaired. The religious spirit has indeed never since found so vast a field, and so free a scope, as under the *régime* of a direct and artless theology, scarcely modified, as yet, by metaphysics, and in no way restrained by positive conceptions, which are traceable at that period only in some unconnected and empirical observations on the simplest cases of natural phenomena. As all incidents were attributed to the arbitrary will of a multitude of supernatural beings, theological ideas must have governed minds in a more varied, determinate, and uncontested way than under any subsequent system. If we compare the daily course of active life as it must have been with the sincere polytheist, with what it is now to the devoutest of monotheists, we can not but admit, in opposition to popular prejudice, that the religious spirit must have flourished most in the first case—the understanding of the polytheist being beset, on all occasions and under the most varied forms, by a multitude of express theological explanations; so that his commonest operations were spontaneous acts of special worship, perpetually kept alive by a constant renewal of form and object. The imaginary world then filled a much larger space in men's minds than under the monotheistic system, as we may know by the constant complaints of Christian teachers about the difficulty of keeping the disciples of their faith up to the true religious point of view: a difficulty which could scarcely have existed under the more familiar and less abstract influence of a polytheistic faith. Judged by the proper criterion of all philosophy, its degree of contrast with the doctrine of the invariableness of natural laws, polytheism is much more imperfect than monotheism, as we shall see when we have to consider the diminution of miracles and oracles wherever even the Mohammedan form of monotheism has prevailed. Visions and apparitions, for instance, are exceptional things in modern theology, reserved for a few privileged persons here and there, and for important purposes; whereas every pagan of any mark had personal intercourse with various deities, on the most trifling subjects, some of his divinities being probably his relations, more or less remote.—The only specious objection to this estimate, as far as I know, is that monotheism is superior to polytheism in inspiring devotion. But this objection (besides that it leaves other arguments unaffected) rests upon a confusion between the intellectual and the social power of religious beliefs; and then upon a vicious estimate of the latter, from bringing the ancient and modern habits of thought too near together. Because polytheism pervaded all human action, it is difficult to determine its share in each social act: whereas under monotheism its co-operation may be much less, while it is more marked, under the clearer separation of the active from the speculative life. It would also be absurd to look to polytheism for the particular kind of proselytism, and therefore of fanaticism, which is proper to monotheism, whose spirit of exclusiveness inspires a repugnance toward all other faiths, which could not be felt in the same degree by men who, admitting a multitude of gods, could not much object to recognise a few more, whenever their admission became possible. The only way of estimating the moral and social efficacy of polytheism is by comparing it with its assigned function, in promoting human progress—that function being very unlike the one appointed to monotheism. In this view we shall find that the political influence of the one was certainly not less extensive or indispensable than that of the other: so that this consideration leaves untouched the various concurring proofs of polytheism being the greatest possible development of the religious spirit, which began to decline, directly and rapidly, on assuming the form of monotheism.

In our examination of polytheism, I shall take first the scientific point of view; then the poetic or artistic; and finally the industrial.

Polytheistic science.

It is easily seen how unfavorable to science must be that theological philosophy which represses all scientific expansion under the weight of detailed religious explanations of all phenomena; thereby affixing the stigma of impiety to every idea of invariable physical laws. The superiority of monotheism in this view will be apparent hereafter; but, however great that superiority may be, it is not the less true that scientific education began under polytheism, and can not therefore be incompatible with it, nor without some encouragement from it.

The first consideration is of the importance of the step taken by human reason in rising from fetichism into polytheism,—the first effort of speculative activity, and the greatest. In this the distinct intellectual life of our race began; and this was the indispensable preparation, without which the conception of invariable natural laws could never have been formed. When all bodies were no longer supposed to be divine in their nature, the secondary details of phenomena were set free for observation, without theological intermixture; and the religious conception related to beings distinct from the body, and residing elsewhere. The general conception of destiny or fate, introduced by polytheism, was also a substantial primitive ground for the principle of the invariableness of natural laws. While phenomena must then have appeared more irregular than we can conceive, polytheism exceeded its aim by presenting such a crowd of heterogeneous and unruly divinities as could not be reconciled with so much of regularity in the external world as must be admitted; and hence the creation of a particular god of immutability, whose supremacy must be acknowledged by all the rest, amidst their proper independence. Thus was the notion of fate the necessary corrective of polytheism, from which it is naturally inseparable; to say nothing of the aid it afforded in the final transition to monotheism. Thus polytheism disclosed an access to the ulterior principle of the invariableness of natural laws by subordinating the innumerable wills of its deities to some steady rules, however obscure those rules might be: and it sanctioned this nascent regularity, in certain respects, in relation to the moral world, which was, in that instance as in every other within the range of theology, the starting-point of all explanations of the physical world: for we always find each divinity preserving his own characteristics, in the midst of the wildest caprices, and throughout the freest excursions of ancient poetry, which indeed could not otherwise inspire any sustained interest. Again, polytheism engaged the awakened scientific spirit in philosophical meditation, by establishing a primitive connection among human ideas, which was not the less infinitely valuable for being chimerical in its nature. Human conceptions then exhibited that great character of unity of method and homogeneousness of doctrine which is the natural condition of our reason, and which has never been paralleled since, nor can be till the positive philosophy shall exercise that full and uniform supremacy which the theological philosophy exercised, in an inferior manner, in its best days. Under monotheism, this particular quality could not flourish, because some human conceptions had passed out of the theological philosophy, so as to change its primitive character very sensibly: and thus it is obvious that the spirit of the whole, or of uniformity, now so rare, might abound at a time when not only were conceptions so few that a single mind could easily embrace them all, but all were subordinated to a theological philosophy which admitted of the mutual comparison of them all. Mistaken as most of the conclusions necessarily were, the state of mind in which they were formed was more natural than the philosophical anarchy which marks the modern transition state; and it is no wonder that eminent thinkers, especially if they belong to the Catholic school, should expressly deplore, at this day, as a radical degradation of our reason, the irrevocable decline of that ancient philosophy which, taking its stand at the source of all things, left nothing unconnected and unexplained, by the uniform application of its theological conceptions. It is certainly impossible not to admire the fitness of the theological philosophy to occasion first, and then encourage, the first expansion of our reason, by administering material and guidance to its activity, till the progress of knowledge allowed a higher system to supersede its provisional protection. And if we consider the determination of the future to be the end of all philosophical speculation, we shall see how theological divination opened the way for scientific prevision, notwithstanding the antagonism in which they must finally stand, and by which the superiority of the positive philosophy is established, on condition of that complete generalization which remains at present unaccomplished.

In a more special and direct way we can see how the polytheistic system aided, in the midst of its fictions and inspirations, the development of a certain capacity of observation and induction, so far, at least, as affording it a vast field and an attractive aim, by connecting all phenomena with the destiny of Man, as the chief object of divine government. The superstitions which now appear the most absurd,—such as divination by the flight of birds, the entrails of victims, etc.,—had a really progressive philosophical character, as keeping alive the stimulus to steady observation of phenomena, which could not otherwise have offered any permanent interest. However fanciful the objects of all kinds of observation, they were thereby collected for a better use at a future time, and would not have been collected at all in any other way. As Kepler observed, astrological chimeras long sustained the taste for astronomical observations, after having created it; and anatomy may have gained as much by the pretensions of soothsayers to ascertain the future by the study of the liver, the heart, the lungs, etc., of sacrificial animals. There are phenomena even now which, by their want of subjection to any scientific theory, makes us almost sorry that this primitive institution of observations, with all its dangers, should have been destroyed before it could be properly replaced, or the mere preservation of its results be guarantied. Such, for instance, are, in concrete physics, the greater number of meteorological phenomena, and particularly those of thunder, which, for the sake of augury, were the subject of scrupulous and continuous observation in ancient times. An unprejudiced mind may lament the total loss of the observations which the Etruscan augurs, for instance, were collecting through a long course of ages, and which our philosophy could make use of at this day, to far better purpose than our meteorological materials compiled without rational guidance. The registers of the augurs could hardly have been worse kept than ours; and a determinate end being indispensable to all true observation, any theory is better than none. The same course of remark may extend to all orders of facts, without excepting even intellectual and moral phenomena, which had been delicately observed in all their connections, with a view to the interpretation of dreams. Such incessant perseverance as the ancients devoted to this study is to be looked for nowhere else but under the future prevalence of positive philosophy.

Such is the scientific aspect of polytheism,—the least favorable of its aspects. Its influence upon the fine arts is more easily appreciable and less disputed. Our concern is however more with the source of the influence than with the result.

Polytheistic Art.

Through a confusion of philosophy with poetry, it is a common mistake to attribute too much to the fine arts in an infant state of society, supposing them to be the intellectual basis of its economy. But philosophy and poetry have at all times been distinct, even before they had obtained their proper denominations, and during that long period when they were cultivated by the same individual minds,—if we except what no one means by poetry—the mnemonic expedient by which religious, moral, and scientific formulas were versified, to aid their transmission. Through all gradations of savage life, the social influence of poetry and the other fine arts was secondary to the theological, to which it lent aid, and by which it was protected, but which it could never supersede. Homer was, after all that has been said, no philosopher or sage, and much less a priest or a legislator; but his lofty intelligence was imbued with the best that human thought had produced in all departments, as has been the case since with all men of poetic or artistic genius, of whom he will ever be the most eminent type. Plato, who must have understood the spirit of antiquity, would certainly not have excluded the most general of the fine arts from his Utopia if its influence had been so fundamental in the economy of ancient societies as is commonly supposed. Then, as in every other age, the rise and action of the various fine arts were occasioned by a pre-existing and universally admitted philosophy, which was only more especially favorable to them in the earliest times. The faculties of expression have never directly overruled those of conception; and any inversion of this elementary relation would directly tend to the disorganization of the human economy, individual and social, by abandoning the conduct of our life to faculties which can do no more than soften and adorn it. The guiding philosophy of that day was very different from ours; but not the less were the men of that day guided by their philosophy; and what is accessory now was, in like manner, accessory then. Many eminent persons in antiquity were almost insensible to the charms of poetry and art, while representing to us very powerfully the corresponding social state; and, conversely, modern peoples are very far from resembling the ancient, though the taste for poetry, music, painting, etc., is purified and extended more and more: far indeed beyond what it could have been in any early society, considering the slaves, who always formed the bulk of the population. This being explained, we may understand how admirable was the influence of polytheism in raising the fine arts to a degree of social power which has never been equalled since, for want of sufficiently favorable conditions. Fetichism favored the poetic and artistic development of humanity, by transferring the human sense of existence to all external objects; and to apprehend the full meaning of this, we must consider that the æsthetic faculties relate more to the affective than to the intellectual life, the latter not admitting of any expression or imitation which can be strongly felt or fairly judged by interpreter or spectator. Having seen how decided was the preponderance of the affective life under fetichism, we perceive how genial the period must have been to the arts of poetry and music, which were the earliest of the class. The external world can never since have been in such familiar accordance with the soul of Man as when all that he saw was alive with his life, and subordinated to his destiny. The too rare fragments of fetich poetry which have come down to us, or over from distant tribes, show this superiority with regard to inanimate beings, which have, in all succeeding states, been much less adapted for poetic, and less still for musical, use. Polytheism compensated in part for this kind of æsthetic inferiority by the ingenious expedient of metamorphoses, which at least preserved the intervention of sentiment and passion in inorganic life; inferior in poetic energy as was this indirect vestige of affective life to the primitive conception of a direct, personal, and continuous vitality. But, as the moral world must be the main object of the fine arts, the one respect in which fetichism favored them was of small importance in comparison with the vast advantages they obtained under polytheism: and this it is which, having established the starting-point of art in an earlier period, we are now to consider.

The advancement of the fine arts is favored by that peculiar attribute of polytheism,—its encouragement of the imagination, which it exalts over the reason; giving to the race a second age analogous to the corresponding period of the individual mind; as the stage of fetichism corresponded with the first period of individual experience,—that of sentiment. This fostering of the æsthetic faculties by polytheism is no doubt the chief cause of the error which supposes polytheism to be altogether a poetical creation: whereas the theological system existed first, and then produced the fine arts, though the intellectual and social function of poetry and the other arts must be more conspicuous and considerable under that *régime* than under those which succeeded. Under polytheism, the æsthetic faculties had a direct, though accessory participation in theological operations of the first consequence; whereas, under monotheism they had no higher office than being concerned in worship, or, at most, in the propagation of religion, without any share in the dogmatic part of the system. Under polytheism, when philosophy had introduced any new divinity, to explain physical or moral phenomena, poetry took up the work, by conferring on the abstract and indeterminate being a costume, manners, and a history, suitable to his function; thus giving to the conception the concrete character which was indispensable to its social and even mental efficacy. In fetichism, all the divinities were concrete, and nothing else; and it was only when the fine arts had attained a kind of dogmatic function under polytheism that they could realize their full expansion; and when they did, they enjoyed an authority and consideration which they could not retain under monotheism. Again, fetichism could not extend, without great delay and difficulty, to the explanation of the moral world: on the contrary, its moral intuition served as the basis of its conception of the physical world; whereas we see in polytheism the great progressive quality of applicability to moral and even social phenomena. Thus, it was in its second stage that theological philosophy became universal, by being extended to that province which became more and more important to it, and which is now all that is left of it. There is no need to point out the æsthetic importance of the extension of the polytheistic philosophy to moral and social phenomena, which must ever be the chief domain of the fine arts.—Once more, polytheism is favorable to those arts, popular as is their character, by giving them so popular a basis as a system of familiar and universal opinions, by which the arts were made an expression of what was in every mind, and the active interpreter and the passive spectator were brought into moral harmony. The want of such harmony is the main cause of the feeble effect produced by the greatest modern works of art, conceived, as they are, without faith, and judged without conviction, and therefore exciting in us no impressions less abstract and more popular than those general ones which are a consequence of our human nature. Now, no succeeding religion was ever so popular as polytheism at its best period;—certainly not monotheism, in its utmost splendor; for polytheism had the advantage of great moral imperfections, which extended and sustained its popular power only too well;—and it is only from positive philosophy, with its system of settled and unanimous opinions, that we can hope for any great expansion of the fine arts, in congeniality with the spirit of modern civilization.

This, then, is one of the services rendered to humanity by polytheism; and a great service it is, as æsthetic advancement is one of the chief elements of human progression. The æsthetic faculties are, in a manner, intermediate between the moral and intellectual faculties; their end connecting them with the one, and their means with the other. By acting at once on the mind and the heart, their development must become one of the most important agents of education, intellectual and moral, that we can conceive. In the rare cases in which the intellectual life of the individual has been too absorbing, the fine arts can revive the moral life, long neglected or disdained: and, with the great majority of men, the converse effect may be no less salutary. In them the intellectual life is benumbed by their affective activity; and the æsthetic development, besides its own permanent importance, serves as an indispensable preparation for its mental progress. This is the special phase which humanity must assume under the direction of polytheism; and thus is attained the first degree of intellectual life, through a gentle and irresistible influence, fraught with delight, independently of its mental action, properly so called. Our daily observation of individual development shows the value of this service, by making it clear that there is scarcely any other way of awakening and sustaining any speculative activity but such as arises under the immediate stimulus that our human necessities afford to our feeble intelligence; and the manifestation of some interest in the fine arts will ever be the commonest symptom of the birth of the spiritual life. It is true this is but an early stage in human education, which must be imperfect till the reason gains the ascendency over the imagination; but if, under fetichism, it was an advance that sentiment should prevail over the animal life; and again, that imagination should obtain an ascendency over sentiment, it is clear that polytheism is a great step forward toward the settled and normal state of that prevalence of reason in the human mind which is aided by monotheism, and will be perfected by the complete establishment of positive philosophy. While the æsthetic and the scientific spirit differ widely from each other, they each employ, in their own way, the same original faculties of the brain; so that the first kind of intellectual activity serves as an introduction to the second, without dispensing with a special intervention which we shall consider when we come to review the operation of monotheism. No doubt, the analytical and abstract spirit of scientific observation of the external world is radically distinct from the synthetic and concrete spirit of æsthetic observation, which seizes the human aspect only of all phenomena, by contemplating their actual influence on Man, in his moral relations; but not the less have they an all-important interest in common, in the disposition to observe accurately, and therefore to institute intellectual precautions of an analogous kind against error in either case. The analogy is yet more complete in whatever concerns the study of Man himself, in which the philosopher and the artist have equal need of some identical ideas, of which they make different uses. The hidden affinity which unites the one and the other spirit, through all their characteristic differences, can not therefore be denied; nor that the more rapid development of the first is an indispensable preparation for the slower growth of the last: and if this relation becomes manifest, in the first instance, among the leaders of intellectual culture, it can not but extend in time to the passive multitude. What I have said would be confirmed at every step, if the nature of this work admitted of a close comparison of the stages of progression of the two orders of ideas—the æsthetic and the scientific; and also if I could speak separately of each art, and show the order of their rise and expansion. My limits forbid me to do this: and I can only assert what every student can verify for himself, that each art has preceded others in proportion to its more general nature; that is, in proportion to the variety and completeness of its power of expression—apart from its distinctness and force. According to this test, the æsthetic series begins with poetry, and proceeds through music, painting, sculpture, and, finally, architecture.

We now see that the excellence of the fine arts in ancient times presents no such paradox as is usually supposed; and that it would be a mistake to imagine that the æsthetic faculties of Man have declined, merely because their exercise is not so prominent, nor so favored by circumstances, as in the age of polytheism. Without renewing the controversy about the ancients and moderns, we may point to unquestionable evidences that human faculties have not declined, even in regard to the fine arts, by passing through the darkness of the Middle Ages. In the first of them, Poetry, our progress is incontestable. Even in the epic form, which is least congenial with modern civilization, we can hardly find nobler poetic genius in any age than that of Dante or Milton, nor any imagination so powerful as that of Ariosto. In dramatic poetry, where shall we find a parallel to Shakspere and the dramatists of his age in England, and Corneille, Racine, and Molière in France? Though Music does not fill such a space in human life now as in ancient times, there can be no question of the superiority of modern Italian and German music to that of the ancients, which comprehended no harmony, and consisted of only simple and uniform melodies, in which measure was the chief means of expression. In Painting, not only is there a prodigious advance in technical methods, but in the loftiest moral expression; and all antiquity produced nothing comparable to the works of Raffaelle, or of many other modern painters. If there is a real exception in the case of Sculpture, it is easily explained by a reference to the manners and habits of the ancients, which familiarized them more with the study of the human form. As to Architecture, besides the improvement of the industrial part of it in modern times, there can be no doubt of its æsthetic superiority, as shown in the cathedrals of the Middle Ages, in which the moral power of the art attains a sublime perfection which is nowhere to be found among the temples of antiquity, notwithstanding the charm of their regularity. And all this progress has taken place amidst a civilization in which æsthetic excitements have hitherto been much less inherent than in that of earlier times. As it is the function of the fine arts to represent our moral and social life, it is clear that, while they are adapted to all phases of human existence, they must be most conspicuous where the character of society is most homogeneous and settled, and therefore best fitted for clear and definite representation; a condition which was afforded, in a pre-eminent degree, by ancient societies, under the empire of polytheism. Modern society, on the contrary, has been, from the beginning of the Middle Ages, one long stage of transition, directed by monotheism—the social state presenting no stable and marked aspect, and the philosophy favoring scientific more than æsthetic development. All influences have thus concurred to retard the course of the fine arts; and yet, all evidence proves that there has not only been no deterioration, but that genius of this order has attained and surpassed the elevation of the noblest productions of antiquity, while it has opened new provinces of art, and declined in no other respect than in social influence. To all who judge by a higher criterion than the effect produced, it must be evident that, in spite of unfavorable circumstances, the æsthetic, like all the other faculties of Man, are under a condition of continuous development. When a stable and homogeneous, and at the same time progressive state of society, shall have become established under the positive philosophy, the fine arts will flourish more than they ever did under polytheism, finding new scope and new prerogatives under the new intellectual *régime*. Then will be seen the advantage of the educational discipline of Man's irrepressible æsthetic faculties which is now going on; and then will be evident to all eyes that radical affinity which, under the laws of the human organization, unites the perception of the beautiful with the relish for truth, on the one hand, and the love of goodness on the other.

Polytheistic Industry.

The influence of polytheism on the industrial aptitudes of the human race will appear hereafter, when we have to consider which of the three forms of polytheism best regulates that province. I need only say here that polytheism provides a great extension and more direct application of the influence by which fetichism first excited and sustained human activity in its conquest of external nature. By withdrawing divinities from their former inseparable connection with particular bodies, polytheism rendered lawful such modifications of matter as would have been profane before; while it imparted a belief in supernatural aid in all enterprises whatever, in a more special and familiar way than we can now conceive. At the same time it instituted a priesthood, to interpret among conflicting claims and appearances; and the multiplicity of gods supplied a valuable special resource to neutralize, by their mutual rivalry, the anti-industrial disposition which we have seen to belong to the religious spirit. Without such a resource, wisely applied by sacerdotal authority, it is evident that the dogma of fatalism, inseparable from polytheism, must have put a stop to the expansion of human activity. There is no disputing the special fitness of polytheism to encourage the development of Man's industrial activity, till, by the progress of the study of nature, it begins to assume its rational character, under the corresponding influence of the positive spirit, which must give it a wiser and bolder direction as it enters upon its great new field.

We must remember that in those early days war was the chief occupation of man, and that we should entirely misjudge ancient industry if we left out of view the arts of military life. Those arts must have been the most important of all, while they were the easiest to improve. Man's first utensils have always been arms, to employ against beasts or his rivals. His skill and sagacity were engaged through many centuries, in instituting and improving military apparatus, offensive or defensive; and such efforts, besides fulfilling their immediate purpose, aided the progress of subsequent industry, to which it afforded many happy suggestions. In this connection, we must always regard the social state of antiquity as inverse to our own, in which war has become a merely accessory affair. In antiquity, as now among savages, the greatest efforts of human industry related to war; in regard to which it accomplished prodigies, especially in the management of sieges. Among us, though the vast improvements in mechanical and chemical arts have introduced important military changes, the system of military implements is far less advanced, in comparison with our resources as a whole, than it was, under the same comparison, among the Greeks and Romans. Thus, we can not form a judgment of the influence of polytheism upon the industrial development of the human race unless we give its due place to the military branch of the arts of life.

Social attributes of Polytheism.

The social aptitude of polytheism remains to be considered, under its two points of view,—the political and the moral,—the first of which was necessarily preponderant; and the second of which shows more than any other aspect the radical imperfection of this phase of the theological philosophy.

The polytheistic priesthood was the first social corporation which could obtain sufficient leisure and dignity to devote itself to the study of science, art, and industry, which polytheism encouraged, and to which ambition urged the priesthood, no less than their vocation called them. The political consequences of such an establishment, in influencing the economy of ancient society, are what we must next ascertain. In its earliest age, the human race always discloses the germs of the chief political powers, temporal and practical, spiritual and theoretical. Of the first class, military qualities, strength and courage first, produce and cunning afterward, are the immediate basis of active authority, even if it be temporary. Of the second class is the wisdom of the aged, which performs the office of transmitting the experience and the traditions of the tribe, and which soon acquires a consultative power, even among populations whose means of subsistence are so precarious and insufficient as to require the mournful sacrifice of decrepit relatives. With this natural authority is connected another elementary influence,—that of women,—which has always been an important domestic auxiliary, bringing sentiment to the aid of reason, to modify the direct exercise of material supremacy. These rudiments of all succeeding establishments of authority would not have passed beyond their incipient stage, if polytheism had not attached them to the double institution of regular worship and a distinct priesthood, which afford the only means of admitting anything like a social organization among scattered families. This is the chief political destination of the theological philosophy; and it is in this, its second stage, that we see how its social prerogative results from the rise of common opinions on subjects the most interesting to Man, and of a speculative class which must be the organ of those opinions. It is in this way, and not so much from fears or hopes of a future life, that religious doctrines have been efficacious in a social sense. The political influence of religious doctrine has never been great: its operation is essentially moral; though even under this aspect, we are too apt to confound with it the repressive or guiding power inherent in the existence of any system of common opinions. Moreover, it is unquestionable that the religious doctrine acquired social importance only at a late period of polytheism; and it was under monotheism that that importance reached its height; as we shall presently see. It is true, there has been no age in which Man did not yield to the natural desire and supposition of his own eternal existence, past and future; a tendency which it is perfectly easy to explain; but this natural belief exists long before it admits of any social or even moral application,—first, because theological theories are very slowly extended to human and social phenomena; and again, because, when this is effected, and the guidance of human affairs has become the chief function of the gods, it is on the present, and not on a future life that the strongest emotions of hope and fear are concentred. The poems of Homer show how new were the moral theories of polytheism relating to future reward and punishment, by the eagerness of the wisest minds to propagate a belief so useful, and so little known among the most advanced peoples: and the books of Moses show that, even in a state of premature monotheism, the rude He-

Polity.

brew nation, not yet susceptible of the idea of eternal justice, feared only the direct and temporal wrath of its formidable deity.

Worship.

In the social phase presented by polytheism, after the establishment of common opinions, and a speculative class as their organ, the nature of the worship was well adapted to the mind of the time, consisting of numerous and varied festivals, favorable to the advancement of the fine arts, and supplying a sufficient ground for assemblages of a population of some extent, connected by a common language. The festivals of Greece preserved their high social importance, as a bond and reconciliation of conflicting nations, till absorbed by the power of Rome. If no power but that of the theological philosophy could organize even the games of the ancients, it is not surprising that all natural authorities should repair for sanction to this source, which alone could give any extension and durability to their social influence; and hence the theocratic character which invests all modes of primitive government.

Civilization by War.

Passing from the passive establishment of a social organization to its active existence,—the first consideration is that life was then military by necessity, not only from the conformity of war with the propensities of the age, but from its being the only means of rendering the political organism durable and progressive. It had a higher and more general function in extending human associations, and devoting the most numerous classes to an industrial life. When we speak of the civilizing qualities of modern war, we commit the great mistake of estimating absolutely what can be only relative, and supposing that to be true of our own time which was true only of a totally different age: but if restricted to the social state of the ancients, or to that of any population at the same stage of progress, it is emphatically true that war was a means of civilization. By the annexation of secondary populations to a preponderant one, human society was enlarged in the only way then possible; while the dominion of the conquering nation could not be established or maintained but by the repression of the military activity of each annexed population; and thus was peace preserved among the subordinates, and opportunity was afforded for their induction into an industrial mode of life. Such is the process by which human societies were disciplined, extended, reconstituted, and led on to their subsequent mode of existence. There can not be a happier instance of the power of intellectual and moral superiority than this, which shows us how propensities which, in every other carnivorous being, lead only to the brutal development of the destructive instincts, become the natural means of civilization. We need no further proof of the aptitude of polytheism to sustain and direct the rise of military activity. We, who make a broad division between the spiritual and the temporal, are apt to say that the ancients had no religious wars: but if this is in any sense true, it is because all their wars had more or less of a religious character; their gods being then national deities, mingling their conflicts with those of their peoples, and sharing their triumphs and reverses. There was something of this in the fierce wars of fetichism, though the family character of the divinities precluded them from any considerable political efficacy; but the gods of polytheism had precisely that degree of generality which allowed them to call entire peoples to their standards, while they were national enough to stimulate the growth of the warrior spirit. In a system which admitted of an almost indefinite addition of new gods, the only possible proselytism was in subjecting the gods of the vanquished to those of the victor; but it certainly always existed, under that characteristic form, in ancient wars, in which it must have largely contributed to excite mutual ardor, even among combatants who practised the analogous worship, but each of whom yet had their national god familiarly incorporated with the whole of their special history. The social operation of polytheism was, while stimulating the spirit of conquest, to incorporate subject nations with the victorious one, permitting each to preserve its own faith and worship, on condition of acknowledging the superiority of the victorious deities; a procedure which, under that *régime*, required no subversion of any religious economy. Under this military aspect, polytheism is superior, not only to fetichism, but even to monotheism. Monotheism is adapted to the more pacific existence of more advanced societies, and does not urge to war, in their case, but rather discourages it: while, with regard to less advanced nations, it does not, because it can not, seek the annexation of other faiths, but is instigated by its own exclusive character to annihilate or degrade conquered idolaters, unless they redeem themselves by immediate conversion. The Jews, the Mahommedans, and others who passed over prematurely into an abortive monotheism before they were socially prepared for the change, are remarkable instances of this. It is unquestionable that these are the qualities which especially adapt polytheism to direct the military development of ancient society.

Sacerdotal sanctions.

Among the accessory resources of the polytheistic system, we may note the quality by which it secured the establishment and maintenance of a strict military discipline, whose prescriptions were easily placed under the guardianship of a suitable divine protection, by means of oracles, augury, etc., always applicable under a regular system of supernatural communication, organized by polytheism, and repressed by monotheism. We must bear in mind the spontaneous sincerity which regulated the use of those means which we are too apt to regard as jugglery, for want of carrying ourselves back to an intellectual condition in which theological conceptions were blended with all human acts, and the simplest movements of human reason were adorned by a religious consecration. If ancient history offers some rare instances of deliberately false oracles having been published for political purposes, it never fails to exhibit also the small success of such miserable expedients, through the radical connection of minds, which must prevent some from firmly believing what others have forged. There is, again, the power of apotheosis, much underrated by us: a power peculiar to this second religious period, and which tended to foster in the highest degree, among superior minds, every kind of active enthusiasm, and especially military fervor. The immortal beatification proposed by monotheism was a poor substitute, because apotheosis under polytheism gratified the universal idea of unlimited life, and added to it the special privilege of promising to vigorous spirits the eternal activity of those instincts of pride and ambition which were the great charm of life in their eyes. When we judge of this resource by the degradation it exhibited in the decrepitude of polytheism, when it was applied to the worst rulers, and had become a sort of mortuary formality, we lose all conception of its power in the days of faith and energy, when eminent persons might hope, by a worthy fulfilment of their social destination, to rise to the rank of gods or demigods, after the example of Bacchus, Hercules, and others. This consideration may show how all the political energies of the religious spirit were applied by polytheism as far as their nature admitted, so that nothing remained but for their intensity to decline. This decline, so mourned at the time as depriving mankind of one of its most powerful actuating forces, but in no way hindering social development, may teach us the value of analogous apprehensions in our own day, when men anticipate social degeneracy from the extinction of the theological *régime* which mankind is discovering to be unnecessary.

Two characteristics of the polity.

Our next consideration must be of the radical conditions of the corresponding *régime*, whose aim and spirit we have been reviewing; in other words, we must examine the chief characteristics which, common to all the forms of such a *régime*, are evidently indispensable to its practical organization.

Slavery.

These are the institution of Slavery, and the confounding of the spiritual and temporal powers, which together constitute the main difference between the polytheistic organism of ancient, and the monotheistic organism of modern societies.

We are all aware how indispensable Slavery was to the social economy of antiquity; but we are apt to overlook the principle of that relation. We have only to extend to the individual case the explanation hitherto applied to nations, of the warlike destination of ancient society, as a necessary means of progression. It is easily seen how slavery was engendered by war, which was its chief source, and its first general corrective. The righteous horror with which we regard existing slavery naturally blinds us to the immense progression which it constituted and caused when it everywhere succeeded to cannibalism or the sacrifice of captives, and the conqueror, curbing his vindictive passions, could become sensible of the advantages he might derive from the services of his captive, by annexing him, as an inferior auxiliary, to the family he ruled.

Such an advance implies an industrial and moral progression much more considerable than is commonly supposed. It was a sagaciout remark of Bossuet's that the etymology of the term reminds us thas the slave was originally a prisoner-of-war who was spared instead of being devoured or sacrificed, according to prior custom. It is probable that without such a resource the blind military passion of the first ages of society would have destroyed nearly the whole race: and thus the immediate benefits of such an institution require no more vindication than its naturalness. Its service to the ulterior development of humanity is no less indisputable, though it is less appreciated. There could have been no sufficient expansion of the military *régime* if all pacific labors had not been assigned to slaves; so that slavery, resulting from war, served afterward to sustain it, not only as a main recompense of victory, but as a permanent condition of the conflict. And again, slavery was no less important to the vanquished, who were thus constrained to an industrial life, notwithstanding their constitutional repugnance to it. Slavery was thus to the individual what we have seen that conquest was to nations. The more we consider the original aversion of our defective nature to regular and sustained toil, the more we shall be convinced that slavery opened the only general issue for the industrial development of humanity; and the better we shall see how labor, accepted at first as a ransom of life, became afterward the principle of emancipation. Thus it was that ancient slavery grew to be, in relation to human progress, an indispensable means of general education, which could not have been otherwise supplied, while it was, at the same time, a merely necessary condition of special development.

Among the many differences which distinguish the ancient from our dreadful modern slavery, the conspicuous fact that the one was in harmony with the spirit of the age, while the other is opposed to it, is enough to condemn the latter. The existing slaveholder enjoys repose at the expense of the toil of his victim; whereas, the ancient conqueror and his captive worked in virtual concert, the activity of each promoting that of the other. Though slaves were, in those days, much more numerous than their masters, slavery existed through a long course of ages without any but extremely rare crises of danger; whereas modern slavery has maintained only an irksome existence for three centuries past, in the midst of frightful and always imminent dangers, notwithstanding the material preponderance of the owners, powerfully assisted by metropolitan civilization. The difference is that the ancient slavery was a normal state, originated by war, and sustained by a multitude of accessory tendencies; whereas modern slavery is simply a factitious anomaly.

The relation of slavery to polytheism may not be evident at first sight, certain as it is made by historical analysis. If we consider, however, that the encouragement of slavery is a mere prolongation of the encouragement afforded to the spirit of conquest, we shall see that this theological state is in harmony with both. Polytheism, in fact, corresponds to slavery, as fetichism does to the extermination of captives, and monotheism, as we shall see, to the emancipation of serfs. Fetichism and monotheism are adverse to slavery,—the one because it is a religion too individual and local to establish any bond between the conqueror and the conquered strong enough to restrain natural ferocity; and the other, because it is universal enough to preclude so profound an inequality between the worshippers of the same true God. Both are adverse to slavery for the same reasons which make conquest an exceptional pursuit for them. The intermediate theological state was therefore the one appropriate to slavery,—being general enough to afford the necessary bond, and special enough to maintain social distance. The victor and the vanquished preserved their respective gods, while there was a common property in their religion which sufficed for a certain agreement; their relation being moreover consecrated by the subordination of the inferior to the superior gods. Thus it was that polytheism precluded the slaughter of captives on the one hand, and their regular emancipation on the other; and thus it consolidated and sanctioned their habitual bondage.

Concentration of spiritual and temporal power.

The next prominent feature of the ancient social economy is the confusion between the spiritual and the temporal powers, united in the same chiefs; whereas their systematic separation is one of the chief political attributes of modern civilization. Speculative authority, which was then purely sacerdotal, and active power, which was essentially military, were always incorporated under the polytheistic *régime;* and such a combination was a requisite to the action of this *régime* on human development. This is the point which we have next to examine.

There could be no recognition, in ancient times, of the separation that was established in the Middle Ages, under the happy prevalence of Catholicism, between the moral power which regulates the thoughts and inclinations, and the political power which is concerned with actions and results. Such a separation supposes a development of the social organism far greater than that of the period when the simplicity and confusion of political ideas precluded any systematic distinction between the establishment of general principles of society and their special and daily use. Nor could such a division take place till each of the two powers had asserted its proper existence, derived from an independent origin; whereas, in ancient times, they were derived from each other—whether military command was simply an accessory of sacerdotal authority, or sacerdotal authority was merely an instrument of military domination. Nor, again, could such a separation take place at a time when the existing polity was confined to a chief city, however it might be destined to spread till it comprehended large populations: whereas, in the Middle Ages, the chief ground of the division was the necessity of attaching to a common spiritual power nations too remote and diverse to be brought into any resemblance in their temporal governments.

Thus the political spirit of antiquity had no more marked characteristic than the pervading confusion between morals and laws, opinions and acts; the same authority presiding over them all, whatever the form of government might otherwise be. Even in contingencies most favorable to the establishment of a distinct spiritual power,—as when a citizen was made dictator without executive office,—even this possession of supreme legislative power never suggested any permanent separation between the moral and the political authority. The schemes of philosophers are always a reflection of the genius of their time; and we find in the boldest proposals of ancient philosophers no hint of a distinction between the regulation of opinions and that of acts; and yet the recognised existence of this class of speculative men among the principal Greek nations must be regarded as the first step toward this very separation. Those of them who went furthest in prescribing a government of philosophers had no other idea than of those philosophers being temporal as well as moral rulers; an arrangement which would have been a greater curse to them than any imperfection of social order under which they were living. This commingling of authority was no less indispensable to the function of the polytheistic *régime* than it was in itself inevitable. Military activity could not have done its work if the same class had not been at once pontiffs and military chiefs, sustaining the rigorous interior discipline required by the nature and duration of the wars of the time; and again, those wars could not have produced their necessary effect if there had not been a collective action in each armed nation upon exterior societies, such as can arise only from a concentration of authority. The continuous development of the spirit of conquest required, in ancient times, a fullness of obedience and a unity of conception altogether incompatible with our modern notions of two coexisting social authorities: and we shall have occasion to observe how closely the division of authority was connected with the decline of the aggressive military system into one purely defensive. If we observe apparent exceptions, as in the case of Mohammedanism, we shall always find, on close observation, that with the monotheism has coexisted the ancient commingling of authority, as well as the spirit of conquest.

It is easy to see how irreconcileable polytheism is with the separation of powers which we shall find to be characteristic of monotheism. Without homogeneousness and consistency, the priesthood could not be securely independent of the temporal power; and the multiplicity of deities rendered such conditions impossible, through the dispersion of theological action which they must cause. At this distance of time, it is difficult for us to conceive of the rivalries which must have existed among different orders of ancient priests, through the inevitable competition of their numerous divinities, whose respective prerogatives, however carefully regulated, could not but frequently conflict; and this must have so far overruled the common instinct of the priesthood as to have precluded or dissolved any considerable sacerdotal coalition, if the temporal power had ever so little desire to hinder it. Whatever were the alliances, avowed or secret, of the various priesthoods, among the best-known polytheistic nations, those priesthoods had a proper and isolated existence till they were all reduced to subjection by the temporal authority, which laid hold of the chief religious functions. Any apparent exception may be considered hereafter: it is enough to say here that it is contrary to the nature of polytheism to allow the existence of a spiritual power, independent of a corresponding temporal power, unless the one is reduced to be the mere appendage or instrument of the other.

Thus we see how the chief political wants of antiquity were met by polytheism, inasmuch as it aided the development of the spirit of conquest, and then established that concentration of social authority which was indispensable to that development. If it be objected that this concentration became the principle of the most degrading despotism, in the hands of infamous rulers; the reply is, that we must judge of the *régime* by its period of highest perfection, and not by any effects belonging to its season of decline. The declining period of all provisional influences exhibits the mischiefs of a too long protraction of any institution: and the case of the military *régime*, with its confusion of social powers, is no exception. When the uses of the system were obtained, dangers which had before been restrained or concealed manifested themselves, in proof that its provisional office was now fulfilled. It only remains for me to observe, under this view of the subject, that there is a close affinity between the two great conditions of the ancient polity. The abolition of slavery has always, as we shall presently find, been coincident with the separation of spiritual and temporal power: a natural consequence of that conjunction of the two authorities which conferred a religious sanction on the dominion of the master, and at the same time exempted this domestic subordination from all such sacerdotal interposition as might restrain that absolute dominion.

Morality

Next to the political analysis comes the moral. I may dismiss it very briefly, so small are its difficulties and its importance in comparison with those of the political analysis of this *régime*. The institution of slavery and the concentration of the spiritual and temporal powers indicate the necessary moral inferiority of the polytheistic to the monotheistic stage of human development.

Moral effects of Slavery.

Morality is profoundly vitiated throughout its relations, personal, domestic, and social, by the mere existence of slavery. There is no occasion to say much of its injurious influence on the servile class; for it can not be necessary to prove that there must be degradation where there is no sense of human dignity, and where the moral nature is wholly neglected, and the evils of servility neutralize all the benefits of labor. Important as such considerations must be, since the bulk of modern population has issued from this unhappy class, and bears only too evident marks of such an origin, the case may be left as it stands before the observation of us all, on account of its being unquestionable. We have therefore only to comment on the effects of slavery on the free,—on the masters,—whose proper development it is more necessary to follow, because it afterward afforded the type of universal evolution. Under this aspect it is evident that this institution, however indispensable to human advancement in a political sense, must seriously impede moral progression. In personal morals, which the ancients knew most about, the effect of a power of absolute command over slaves who were bound to bear whatever caprice might inflict, was of course to impair that power of self-rule which is the first principle of moral development—to say nothing of the dangers from flattery which beset every free man. As to domestic morals, De Maistre was no doubt right in the remark that slavery must have corrupted the primary family relations through the fatal facility it offered to licentiousness; so that even the establishment of monogamy was little more than a profession. As for social morality,—which consists mainly in the love of mankind,—it is sufficiently evident that the universal habits of cruelty, often gratuitous and arbitrary, exercised toward the unprotected slaves, must foster those propensities of hardness and even ferocity, which were ordinary features of ancient manners, blighting even the best nature with moral injury. No less fatal were the consequences of the other political features of the *régime*. It was through the confusion of the spiritual and temporal power that the morality of those times was subordinated to the polity; whereas, in modern days, and especially under the reign of Catholicism, morality, in its independence of polity, has more and more assumed its direction, as I will presently explain. So vicious a subjection of the general and permanent in morality to the special and unstable in politics must impair the consistency of moral ordinances, and corrupt their purity by postponing the estimate of the means to that of the immediate personal end, and inducing a contempt of the fundamental attributes of humanity in comparison with those required by the existing needs of a variable policy. Inevitable as such an imperfection must be, it is not the less real, nor the less deplorable. The morality of the ancients was, in fact, like their polity, essentially military. When nations were adapted for a warlike destination, that aim became the supreme rule in the estimate of moral dispositions, which were esteemed in proportion to their aptitude to aid the great design, whether in the way of command or obedience. Again, there was an absence of all moral education, which monotheism alone could institute. There was no compensation for this great elementary function in the arbitrary intervention of the Greek or Roman magistrate, when he imposed minute, capricious, and fallacious regulations upon private conduct. The only resource for supplying in any degree this enormous omission was to insinuate a kind of moral instruction into the popular mind by means of festivals and

Subordination of morality to polity.

shows, such as have lost their chief importance to society by having deputed their moral function to a better instrumentality. The social action of philosophers, among the Greeks first, and then the Romans, had no other destination ; and this mode of abandoning such a function to private agency, without any legitimate organization, could only disclose the imperfection, in regard to morality, of the *régime*, without adequately repairing it ; for influence of that nature could amount to little more than declamation, always impotent and often dangerous, whatever may have been its provisional utility in preparing a future regeneration. The causes of the moral inferiority of the polytheistic organism are now clear enough. If we take the point of view of the ancients regarding their morality in its relation to their polity, we cannot but admire its aptitude as an aid to their military activity : and in this direction, it has shared the general human progression, which could not have taken place in any other way. But it is no less strikingly imperfect, if regarded as a necessary phase of the moral education of mankind. It is not that the sanction of human passions was fatally authorized or facilitated by polytheism. Though there was something of this, the mischief is greatly overrated by Christian philosophers, who seem to think that no morality could resist such a solvent : yet polytheism destroyed neither the moral instinct of the race, nor the gradual influence of the spontaneous observations on the qualities of our nature and their consequences, which good sense presently amassed. On the other hand monotheism with all its superiority in this respect, has not realized its intrinsic morality any better in those exceptional cases in which it has coexisted with any slavery and the confusion of the two social powers. It is observable, too, that this tendency, with which polytheism is so harshly reproached, and which was a necessary consequence of the extension of theological explanations to moral subjects, afforded a free and natural scope to various human feelings, which had been too much repressed before to have indicated in any other way how far they should be encouraged or neutralized, when morality had become possible. The eminent superiority of monotheism should not therefore induce us to disallow the participation of polytheism in the office of theological philosophy, whether as an organ of the advancing race in establishing certain moral opinions, which must be rendered almost irresistible by such universality ; or by sanctioning those rules by the perspective of a future life, in which the theological, aided by the æsthetic spirit, set up its ideal type of justice and perfection, so as to convert into a powerful moral auxiliary a spontaneous infantile belief in the eternal prolongation of its favorite enjoyments. A rapid survey in truth convinces us that polytheism instigated the moral development of mankind in all important aspects, independently of its special encouragements of qualities most suitable to the purposes of the first age of society.

Personal morality.

Its efficacy is above all conspicuous in relation to the two extreme terms of morality,—the personal and the social. The military application of the first was evident enough to secure especial attention to it; and the active and passive energy which is the prime virtue of savage life was carefully developed. Begun under fetichism, this development was carried forward to perfection under polytheism. The simplest precepts relating to this elementary class of virtues required the intervention of the religious spirit; and there is no doubt that its sanction was given to habits of physical purification, in which we find the first example of that superintendence of himself which Man must institute, for any purposes of action or resistance. As to social morality, it is clear that polytheism encouraged in the highest degree that love of country which took its rise under fetichism. Beginning in the fetich attachment to the native soil, it was stimulated by the national character of polytheism, till it attained the dignity of a rooted and invincible patriotism, often exalted into a conspicuous fanaticism, and constituting the great and almost the only aim of moral education. We see at once its bearing upon social progress, and how it must have been fostered by the small extent of nationality of that age, and also by the character of its wars, which rendered death or slavery always imminent, and devotion to country the only salvation. A certain degree of ferocity attended this virtue, as it bound up a hatred of foreigners with an attachment to a small number of compatriots; but it was a stage in the progress toward that love of the whole human race which was introduced by Christianity, and which would have been wholly incompatible with the military tendencies of antiquity. To polytheism we must also refer the first regular organization of morality in regard to old age and ancestry, a veneration for which was indispensable to that sense of social perpetuity which becomes more and more important as theological hopes of a future life lose their power, and till the positive philosophy establishes it for ever by exhibiting the connection of the individual with the whole human race, past, present, and future.

Social morality.

Domestic morality.

The most imperfect part of morality under polytheism was the domestic. It was, as it were, dropped between the personal and the social morality, at a time when they were too directly connected, in consequence of the supremacy of political considerations. We shall see presently how it is the immortal honor of Catholicism that it instituted a sound organization of morality by connecting it chiefly with the life of the Family, and making the social virtues depend on the domestic. Polytheism, however, effected a beginning of domestic morality; and it was under its reign that mankind rose to a settled monogamy. Though polygamy is still erroneously attributed to climate, any one may satisfy himself that it has been, in the North as much as the South, an attribute of the first age of human development, immediately following that in which the difficulty of subsistence controlled the reproductive instinct. Necessary as polygamy was in its own season, there is no doubt that the state of monogamy is the most favorable to the development of the best qualities of human nature, in both sexes; and the dawning conception of this social condition led, in the early days of polytheism, to the first establishment of monogamy, followed by necessary prohibitions of incest. Successive improvements of the conjugal relation accompanied the chief phases of the polytheistic *régime;* but the social character of Woman was far from being duly ascertained, while her unavoidable dependence on Man encouraged too much of his primitive rudeness. This first imperfect rise of the distinctive feminine character is exhibited in the constant though secondary participation of women in sacerdotal authority, which was expressly granted to them under polytheism, and taken from them by monotheism. As civilization develops all intellectual and moral differences, and therefore among others, those of the sexes, we can no more derive a favorable presumption of the corresponding condition of women because they shared the priesthood, than because they shared war and the chase —which there is no reasonable doubt that they did. There is, in fact, abundant proof that the social state of Woman was radically inferior under the polytheistic *régime* to what it became in the reign of Christianity. In times when men were hunters and herdsmen, and then when they were warriors, the sexes were too much separated, and their affections were bestowed otherwise than on each other: and then came the institution of slavery, which tended to impair the conjugal relation very seriously. But, in spite of these evils, polytheism certainly did initiate domestic morality, though less effectually than personal and social morals.

Three phases of Polytheism.

Our examination of polytheism must, I think, convince us that notwithstanding vast deficiencies and imperfections, this homogeneous and well-connected system could not but produce men of greater consistency and completeness than the world has since seen under a condition of humanity less purely theological, while not as yet purely positive. However this may be, one more task remains, to complete our estimate. We must review the different forms assumed by the system, according to the office it had to fulfil, in aiding human progress. We must distinguish between theocratic and military polytheism, according to the more temporal character assumed by the concentration of the two powers. Then again, in the military system, we must consider the rising stage of the spirit of conquest, and that of its completion: and thus, the polytheistic *régime* will naturally divide itself into three parts, which we may call, in an historical way, the Egyptian method, the Greek, and the Roman. We will now consider the proper prerogative and invariable succession of the three.

The Egyptian or theocratic.

The intellectual and social elements of a primitive civilization can expand only under the almost absolute rule of a sacerdotal class. Prepared by fetichism in its advanced state of star-worship, and perhaps before the entire transition from the pastoral to the agricultural life, the system could be developed only under the ascendency of polytheism. Its general spirit con-

Caste.

sists in the hereditary transmission of functions or professions which is embodied in the institution of Caste, ruled by the supreme caste of the priesthood, which, being the depository of all knowledge, established a connection among all the heterogeneous corporations which took their rise from families. This ancient organization, not framed for purposes of war, though largely extended by it, did not assign the lowest and most numerous caste to a state of individual slavery, but to one of collective servitude, which is even more unfavorable than that of slavery to ultimate emancipation. The inevitable tendency of nascent civilization to such a system appears to me to be a law of social dynamics. We see it now in the Asiatic races so exemplified that we are apt to regard it as proper to the yellow races, though the white races were in their season equally subject to it, with the difference that, from their inherent superiority, or through the influence of more favorable circumstances, they disengaged themselves more rapidly from it. But the system could become thoroughly characteristic only under conditions which repressed warlike propensities, and favored the sacerdotal spirit. The local causes were a combination of a fine climate with a fertile soil, favoring intellectual development by making subsistence easy; a territory admitting naturally of internal communication; and a country so isolated as to be secure from invasion, while offering no strong inducements to a life of war. These conditions are best found in the valley of a great river, separated from the rest of the world by the sea on the one hand, and inaccessible deserts or mountains on the other. Thus the great system of castes flourished first in Egypt, Chaldæa, and Persia; and it abides in our day in those parts of the East which are least exposed to contact with the white nations, as in China, Japan, Tibet, Hindostan, etc.; and from analogous causes, it was found in Mexico and Peru at the time of their conquest. Traces of these causes may be recognised in all instances of indigenous civilization, as in Western Europe, among the Gauls, the Etruscans, etc. The primitive influence may be perceived among nations whose progress has been accelerated by fortunate colonization. The general impress is recognized in their various ulterior institutions, and is not entirely effaced in the most advanced societies. In short, this system is the universal basis of ancient civilization.

The universality and tenacity of the system of Caste are a sufficient proof of its suitability to human needs, in its season, notwithstanding the inconveniences it involved. Nothing, indeed, could be more natural, at the outset, than that, by domestic imitation, the easiest and most powerful means of education, employments should descend from fathers to sons; and it was the only possible training in an age when oral transmission was the sole means of communicating conceptions. In fact, there is, and always will be, a tendency, though ever diminishing, to the hereditary adoption of employments, however different the modern method may be from the ancient, in which the succession was tyranically decreed by law. When men have no special impulse to a particular occupation, they naturally adopt that of the family; and the only way of diminishing the tendency is by improving general education, so as to provide by abstract and systematic instruction the training which formerly required a concrete and empirical domestic apprenticeship. It was in this way that Catholicism put an end to the hereditary practice of the priesthood, which was once as universal as that of any other functions whatever, public or private.

The distinguishing properties of the system are not less evident than its natural origin. We owe to it the first permanent division between theory and practice, by the institution of a speculative class, invested with grand prerogatives of dignity and leisure: and to this period we must refer the primitive elements of genuine knowledge—it being that in which the human mind began to regulate its general course. The same may be said of the fine arts, then carefully cultivated, not only for the sake of their charm, but as tributary to dogma and worship on the one hand, and information and religious propagation on the other. The industrial development was the most remarkable of all, requiring no rare intellectual qualifications, inspiring no fear in the ruling class, and furnishing, under the reign of peace, forces adequate to the most colossal undertakings. The loss of many useful inventions before the preservative institution of caste arose must have suggested the need of it, and have proved its advantages afterward in securing the division of labor which was here and there attained. No institution has ever shown itself more adapted to honor ability of various kinds than this polytheistic organization, which often exalted into apotheosis its commemoration of eminent inventors, who were offered to the adoration of their respective caste. In a social view, the virtues of the system are not less conspicuous. Politically, its chief attribute was stability. All precautions against attack from within and from without were most energetically instituted. Within, all the castes were united by the single bond of their common subordination to the sacerdotal caste, from which each derived all that it had of special knowledge and perpetual instigation. There never was elsewhere such a concentration, for intensity, regularity, and permanence of human power, as that possessed by the supreme caste, each member of which (at least, in the higher ranks of the priesthood) was not only priest and magistrate, but also philosopher, artist, engineer, and physician. The statesmen of Greece and Rome, superior as they were in accomplishment and generality to any examples that modern times can show, appear but incomplete personages in comparison with the fine theocratic natures of early antiquity, of whom Moses is the most familiar if not the most accurate type. The only pressing external danger was from the growth of military activity, for which, however, the sacerdotal policy found employment, when necessary, in distant expeditions and irrevocable colonization. As to its influence on morals, this system was favorable to personal morality, and yet more to domestic, till the military phase of polytheism became preponderant; for the spirit of caste was a mere extension of the family spirit. The condition of Women was improved, notwithstanding the prevalence of polygamy; for they were rescued from the subjection to rude toil which had been their lot in a barbaric age; and their seclusion, according to the customs of polygamy, was the first token of homage, and of their assignment to a position more conformable to their true nature. As to social morals—the system was evidently favorable to respect for age, and homage to ancestors. The sentiment of patriotism did not as yet transcend love of caste, which, narrow as it appears to us, was a necessary preparation for the higher attachment. The superstitious aversion to foreigners which exists under a system of caste must not be confounded with the active contempt maintained at a later period by military polytheism.

Notwithstanding all these qualities, the theocratic system could not but be hostile to progress, through its excessive stability, which stiffened into an obstinate immoveableness when new expansions required a change of social classification. The supreme class appropriated all its immense resources of every kind to the preservation of its almost absolute dominion, after it had lost, by long enjoyment of power, the chief stimulus to its own progression. At first sight, the political system looks well, in its aspect of a reign of mind; though it was rather a reign of fear, resting as it did on the use of superstitious terrors, and the spells offered by the possession of the earliest physical knowledge; but we must frankly admit, on consideration, that the political rule of intelligence is hostile to human progression. Mind must tend more and more to the supreme direction of human affairs; but it can never attain it, owing to the imperfection of our organism, in which the intellectual life is the feeblest part; and thus it appears that the real office of mind is deliberative; that is, to modify the material preponderance, and not to impart its habitual impulsion. The same comparative feebleness which precludes the dominion of intelligence would render such dominion dangerous, and hostile to progress; for it would lose its chief stimulus, and, being adapted to modify and not to command, it would be occupied in maintaining its monstrous ascendency, instead of advancing toward perfection. I shall have to enlarge further on this consideration in another chapter. I advert to it here because it discloses the principle of the stationary character imputed to the theocratic system by the very persons who profoundly admire its apparent rationality. It is clear, from this point of view, that the extreme concentration of powers which gives its consistency to the theocratic system must retard human advancement, because no separate portion could make any progress without involving the great whole so bound up together. In regard to science, for instance, which ought to be the glory of the system, we know that scarcely any progress was made, not only from want of stimulus, but because any considerable development of science would have been fatal to the whole social economy. We all know that, after the first mental revolution, the sciences can flourish only by being cultivated for their own sakes, and not as instruments of political rule; and analogous considerations hold good of every other department of the social system. Thus, we must admit that the theocratic *régime* institutes a general human progression: and that it afterwards retards that progression. In any nation in which the military caste has failed to subordinate the sacerdotal, no immediate triumph of the military caste has saved it from submission, sooner or later, to the sacerdotal. The vanquished have absorbed the victors: the conquering foreigner has ended by being chief among the native priests, and everything goes on much as before. The case is the same when, by internal revolution, military chiefs have triumphed over the priests; they soon involuntarily acquire the theocratic character, and all that has happened has been a change of persons or of dynasties. The transition from theocratic to military polytheism was effected by means of populations whose external circumstances were unfavorable to theocracy and favorable to war; and by means of that colonization which, issuing from a society of castes, could not plant down the political qualities of the institution on a new soil, though they might retain its intellectual and moral advantages. While the hereditary principle continued to settle almost everything, the grand new power of choice for personal qualities was introduced—remaining subordinate to the old principle for awhile, but ever gaining in extent and independence. The political equilibrium of the two principles, which might at length be obtained, depended mainly on the contemporary degree of military activity, which was an admirable test of the merits of corresponding vocations. Thus, the balance was maintained among the Romans for a course of centuries, as an indirect but necessary consequence of the expansion of the system of conquest; whereas, among the Greeks, for an opposite reason, legislators and philosophers had always been laboriously striving to reconcile what they called oligarchy and democracy, and always pretty much in vain.

The Greek, or intellectual.

When we turn from theocratic to military polytheism, we find a distinction arising between intellectual and social progression, which were hitherto inseparable. The intellectual is represented by the Greek *régime*, which was intermediate between the Egyptian and the Roman, being more intellectual than the one and less social than the other. In Greek society there was abundance of military activity; but it was, in relation to human progression, merely desultory, leaving to the Romans the political function of permanent conquest. Greece was the scene of perpetual conflicts of small states, till Roman dominion spread over all. The peculiarity is explained partly by geographical causes,—the singular partition of territory by gulfs, isthmus, and mountain chains, favoring divisions into states; and partly by the social cause of these states having populations almost identical in language, and the origin and degree of civilization of their colonies. From these causes arose the inability of the Greek states to employ a warlike activity equal to that of the Romans in subjugating their nearest neighbors, and the necessity of pushing it to a distance; thus pursuing a course inverse to that of Rome, and radically incompatible with the progressive establishment of such an extended and durable dominion as might furnish a solid basis for the ulterior development of humanity. Thus it was that the Athenian people, triumphant in the Archipelago, in Asia, in Thrace, etc., was confined to a central territory no larger than our modern provinces, camped about with numerous rivals who could not be subdued; so that Athens might more reasonably propose the conquest of Egypt or Asia Minor than of Sparta, Thebes, or Corinth, or even of the little adjacent republic of Megara. Thus while there was military activity enough to preserve the Greeks from the intellectual and moral torpor induced by theocracy, their military life was not preponderant enough to engross the faculties of the most eminent men, who could not feel an exclusive interest in the futile struggles of which Greek wars mainly consisted. Their cerebral energy, finding no adequate political occupation, was thrown back upon the intellectual life; and the masses, under the same influences, were disposed toward the same culture, especially in the direction of the fine arts. Still, the germs of this intellectual and moral development were derived from theocratic societies, by means of colonization. Through the concurrence of these conditions there arose in Greece an entirely new class, destined to be the organ of mental progression, as being eminently speculative without being sacerdotal, and active without being engrossed by war. By a slight change of this antagonism, in both directions, the philosophers, men of science, and artists, continued to be simply pontiffs, more or less elevated in the sacerdotal hierarchy, or became humble servitors, charged with the instruction of great military families. Thus, though military activity was politically barren among the Greeks, it wrought in favor of human progression, independently of its special importance in rescuing from theocratic influences that little nucleus of free-thinkers who were in some sort charged with the intellectual destinies of our race, and who would probably have been overwhelmed in theocratic degradation, but for the sublime achievements of Thermopylæ, Marathon, Salamis, and of Alexander in his immortal career of conquest.

Science.

Of the operation of the Greek *régime* on the fine arts enough has been said for my purpose here. As to the scientific aspect, as a manifestation of a new intellectual element, largely affecting the rise of philosophy, we must fix our attention on the formation, nearly thirty centuries ago, of a contemplative class, composed of free men, intelligent and at leisure, with no determinate social function, and therefore more purely speculative than theocratic dignitaries, who were occupied in preserving or applying their predominant power. In imitation of their sacerdotal precursors, these sages or philosophers at first cultivated all the parts of the intellectual domain at once,—with the one exception that poetry was early separated from the other fine arts in virtue of its more rapid expansion: but soon, that great division arose which furnished the basis of our scientific development, when the positive spirit began to manifest itself, amidst the philosophy, first theological and then metaphysical, which governed all ancient speculation. The first appearance of the true scientific spirit was naturally in the form of mathematical ideas,—the necessary origin, from their simplicity, generality, and abstract character, of rational positivism. It was by these qualities that mathematical ideas were the first to be withdrawn from the theological jurisdiction under which they had been only implicitly comprehended; and it was through them that purely arithmetical ideas were a subject of study before geometry was disengaged from the art of measurement, with which it was incorporated in theocratic speculation. The very name of the science, however, indicates a culture almost as ancient: and geometry, properly so called, could alone offer an adequate field for arithmetical, and yet more for algebraic pursuit; which could not at first be separated. Thence Thales derived the first true geometry, which he presented in his fundamental theory of rectilinear figures, soon extended by the immortal discovery of Pythagoras, which might indeed have been derived from the theorems of Thales on proportional lines, if the power of abstract deduction had been sufficiently advanced, but which proceeded from the distinct principle of the direct study of areas. The well-known fact of Thales teaching the Egyptian priests to measure the height of their pyramids by the length of their shadows is, to the thoughtful, a symptom of vast significance, disclosing the true state of science, still absurdly exaggerated in favor of ancient theocracy, while it exhibits the intellectual progress already made when human reason began to deal, for purposes of scientific utility, with an order of phenomena which had hitherto been merely a subject of superstitious terror. From that date geometry rose, by the aid of the invention of conic sections, to the perfection which it exhibited in the genius of Archimedes, in whom we recognize the eternal type of the true geometer, and the originator of the fundamental methods to which we owe all subsequent progress. After him, I need specify (except perhaps Apollonius) only Hipparchus, the founder of trigonometry (after the preparation made by Archimedes), the inventor of the chief methods of celestial geometry, and the indicator of its practical relations, in regard to the ascertainment of time and place. Mathematical speculation then offered the only field for scientific activity, for reasons exhibited in the whole course of this work, and illustrated by the very name of the science indicating its exclusive positivity at that period. The study of life by the physician Hippocrates, and the works of Aristotle on animals, meritorious as they are, could not so affect the human mind as to render it adequate to sciences of such complexity as to require a systematic creation in a remote future.

With this advent of rational positivity came in that spirit of special research which at once distinguished the new order of speculations from the indeterminate contemplations of the ancient philosophy. Our modern need is of new generalities; but the case of the ancients was very different. The pursuit of specialities then involved no political disadvantages; and it was the only means by which, independently of the common need of division of employments, the human mind could learn to penetrate the depths of any subject whatever. In short, the scientific spirit was not, under the theological *régime*, the chief ulterior element of the positive *régime*, but only destined for its remote preparation; and it must therefore be special in its character, or fail altogether: and there is, in fact, no doubt that men of science, properly so called, began to appear as a separate class from the philosophers, at the memorable epoch distinguished under this point of view by the foundation of the museum of Alexandria, directly adapted to satisfy this new intellectual need, when progressive polytheism had achieved its final triumph over the stationary.

Philosophy.

As for the purely philosophical development, it had for some time before its separation from the scientific, been influenced by the nascent positivity. This is shown by the marked intervention of metaphysics. Before astronomical study had begun to disclose the existence of natural laws, the human mind, eager to escape from the exclusively theological *régime*, was searching among rudimentary mathematical conceptions for universal ideas of order and fitness, which, confused and illusory as they were, were a genuine first presentiment of the subjection of all phenomena to natural laws. This original loan of science to philosophy was the basis of the whole Greek metaphysics; and the metaphysical spirit followed upon mathematical discovery, passing from the mysteries of numbers to those of forms, as science proceeded from arithmetic to geometry, and at length comprehended both classes of ideas. Aristotle's mighty work will always be the most admirable monument of this philosophy, and an immortal testimony to the intrinsic power of human reason in a period of extreme speculative imperfection, passing sagacious judgment on the sciences and fine arts, and omitting from his range of conceptions only the industrial arts, which were then thought beneath the notice of free citizens. When the Alexandrian establishment had separated philosophy into natural and moral, it obtained a more and more active social existence, and strove for ever-increasing influence upon the government of mankind. Notwithstanding the strange extravagances of this new phase, it was as necessary as the first in preparation for the monotheistic *régime*, not only as precipitating the decline of polytheism, but as unconsciously supplying, as we shall see, a germ of spiritual reorganization. If we made a thorough examination into the series of speculations on the supreme good, we should discover a tendency to conceive of social economy in complete independence of all theological philosophy. But such a hope could have none but a critical influence, like all that sprang from this philosophy, which was the active organ of an intellectual and moral anarchy very like our own. Its radical unfitness to be a basis of even mental, and much more social organization, is unquestionable, at the time of its chief spiritual activity, as we see by the continuous progress of universal and systematic doubt, leading every school from Socrates to Pyrrho and Epicurus to a denial of all external existence. This strange issue, directly incompatible with any idea of natural law, discloses the radical antipathy between the metaphysical spirit and the positive, from the time of the separation of philosophy from science; a separation which the good sense of Socrates saw to be impending, but without suspecting either the limits or the dangers involved. Its distinctive social action throughout its whole course, reprobated as it will ever be by posterity, was well represented by the noble Fabricius, when, speaking of Epicureanism, he regretted that such a moral philosophy as that did not prevail among the Samnites and the other enemies of Rome, because it would then be so easy to conquer them. Its intellectual action was scarcely more favorable; as we may judge by the fact that when the separation between philosophy and science had gone sufficiently far, the most eminent philosophers were ignorant of knowledge which was popularized in the school of Alexandria; as when the philosophy of Epicurus put forth those strange astronomical absurdities which the poet Lucretius piously repeated, half a century after the time of Hipparchus. In short, metaphysics desired to be so independent and absolute as to be emancipated from the only two powers that can organize,—theology and science.

The Roman or Military.

The Roman civilization will not detain us so long as the Greek. It is more simple and marked; and its influence on modern society is more complete and evident. I may point out here, that in assigning the names Greek and Roman to certain phases of civilization, I am not deserting my abstract method of research, but rendering those names abstract, by making them the representatives of certain collective conditions. Antiquity presents many populations animated by military activity, but prevented by circumstances from fulfilling a career of conquest; and, on the other hand, inverse influences have favored an opposite state. Each case must, in its extreme, furnish an instance of preponderant political or intellectual superiority. The system of conquest could not be completely carried out by more than one power: and the spiritual action which was compatible with the age, must operate from a single centre first, whatever the ulterior propagation might amount to. The further we examine, the more we shall see that there has been nothing fortuitous about this double process of human advancement, even in the places and times indicated by these representative names. As to the places, it is obvious that the two movements, political and intellectual, go forward in scenes sufficiently but not too remote, so that at the outset the one should not be absorbed or perverted by the other, while yet they should be able, after a certain progress had been made, to penetrate each other, so as to conduce and converge equally to the monotheistic *régime* of the Middle Ages, which we shall soon see to have issued from this memorable combination. As to the time, it is obvious that the mental progression of Greece must precede by some centuries the extension of the Roman dominion, the premature establishment of which would have radically impeded it by crushing the independent activity from which it arose: and if the interval had, on the other hand, been too great, the universal propagation and social use would have failed, because the original movement, which could not be of any great duration, would have become too much weakened at the time of contact. On the other hand, when the first Cato insisted on the explulsion of the philosophers, the political danger from metaphysical contagion was pretty nearly gone by, since the Roman impulsion was by that time too decided to be really liable to such adulteration: but if a permanent contact had been possible two or three centuries earlier, it would certainly have been incompatible with the free and unmixed course of the spirit of conquest.

The more we study the Roman people, the more we see that it was indeed destined to universal empire, as its own poet said, and as every citizen perseveringly and exclusively desired. The nation freed itself from its theocratic beginning by the expulsion of its kings, but securing its own organization by means of the senatorial caste, in which the sacerdotal was subordinated to the military power. When this wise and energetic corporation of hereditary captains failed to yield to the people or the army such influence as might attach them to the system of conquest, the natural march of events had the needed effect. Generally speaking, the formation and improvement of the internal constitution, and the gradual extension of external dominion, depended on each other much more than on any mysterious superiority of design and conduct in the chiefs, whatever may have been the influence of individual political genius, to which a vast career was thus opened. The first cause of success was the convergence of all the means of education, direction, and execution, toward one homogeneous and permanent end, more accessible than any other to all minds, and even to all hearts. The next cause was the gradual course of the progression. When we see this noble republic devoting three or four centuries to the solid establishment of its power in a radius of under a hundred miles, about the same time that Alexander was spreading out his marvellous empire in the course of a few years, it is not difficult to foresee the fate of the two empires, though the one usefully prepared the East for the succession of the other. Another cause of success was the course of conduct steadily pursued toward the conquered nations; the principle being that of progressive incorporation, instead of the instinctive aversion to

Conquest.

foreigners which elsewhere attended the military spirit. If the world, which resisted every other power, rather welcomed than withstood the Roman rule, it was owing to the new spirit of large and complete aggregation which distinguished it. When we compare the conduct of Rome toward vanquished, or rather incorporated peoples, with the dreadful vexations and insulting caprices that the Athenians (who were otherwise very attractive) heaped upon their tributaries, and even at times on their allies, we see that the Greeks aimed at making the most of a precarious sway, while the Romans were securely advancing toward universal supremacy. Never since that period has the political evolution been manifested in such fullness and unity, in the people and their leaders—the end being kept in view. **Morality.** The moral development was in harmony with the same end—the individual man being disciplined for military life, aud domestic morality being unquestionably higher than in Greece. The most eminent Greeks wasted much of their leisure among courtesans; whereas among the Romans the social consideration and legitimate influence of women were largely increased, while their moral existence was more strictly confined to the purposes of their destination. The introduction of family names, unknown in Greece, is a sufficient testimony to the growth of the domestic spirit.—Social morals also were in a rising state, notwitstanding the hardness and cruelty to slaves, customary in that period, and the ferocity encouraged by the horrible nature of popular amusements, which shock the feeling of a modern time. The sentiment of patriotism was modified and ennobled by the best disposition toward the vanquished, and had something of the character of the universal charity soon to be proposed by monotheism. This remarkable nation presents the supreme case of the political government of morality; so that the morality may be divined by a direct consideration of the polity. Born to command in order to assimilate; destined to extinguish by its own ascendancy the barren military activity which threatened to disintegrate humanity; accepting only to discard the common tendencies of original civilization, this noble nation manifested, amid its prodigious imperfections, an assemblage of qualities adapted to its mission; a mission which, being fulfilled and incapable of reproduction, will immortalize the name of Rome to the remotest ages of political existence. **Intellectual developement.** The intellectual development could be no nore than accessory; consisting in extending the mental action induced by Greek civilization; and this it accomplished with an earnestness that contrasts well with the peurile jealousies which still further divided the Greek mind. The Roman imitations were necessarily inferior to the Greek originals; but there were some exceptions to this inferiority, especially in the historical department, as was natural. The decline of Rome testifies to the justice of our estimate of its mission. When its dominion could be extended no farther, this vast organism, having lost its moving principle, fell into dissolution, exhibiting a moral corruption without parallel in the history of society; for nowhere else has there existed such a concentration of means, in the form of power and wealth, in the absence of any end. The passage of the republic to imperial government, though evidently compelled by the circumstance which converted extension into preservation, was no reorganization, but only a mode of chronic destruction of a system which must perish because it did not admit of regeneration. The emperors were mere popular chiefs, and, introducing no fresh principles of order, only accelerated the decline of the senatorial caste, on which everything depended, but whose function was now exhausted. When Cæsar, one of the greatest of men, sank under the alliance of metaphysical fanaticism with aristocratic rage, this foolish and odious murder had no other issue than raising to the leadership of the people against the senate men much less fit for the government of the world; and none of the changes which ensued ever admitted of any return, however temporary, to the genuine Roman organization, because its existence was inseparably connected with the gradual extension of conquest.

Having thus reviewed the three essential phases of ancient polytheism, we have only to indicate the tendency of the whole *régime* to produce the monotheistic order of the Middle Ages, by which the relative character of polytheism will be indisputably established.

Preparation for Monotheism.

In an intellectual view, the filiation is perfectly clear; the necessary and continuous destination of the Greek philosophy being to serve as the organ of the irrevocable decline of polytheism, in preparations for the advent of monotheism. The only essential rectification of modern opinion required in this matter is to recognise, in this great speculative revolution, the latent influence of the nascent positive spirit in giving an intermediary character to this philosophy, which, ceasing to be wholly theological, and unable as yet to be scientific, constitutes that temporary chronic malady, the metaphysical state. The confused sense of the necessary existence of natural laws, awakened by the introduction of geometrical and astronomical truths, was the only means of giving any philosophical consistence to that universal disposition to monotheism which arose from the steady progress of the spirit of observation, circumscribing supernatural intervention till it was condensed into a monotheistic centre. If no theological unity was possible amidst the instability, isolation, and discordance of primitive observations of nature, neither could reason be satisfied amidst the contradictions of a multitude of capricious divinities when the regularity of the external world was becoming more apparent as observation extended. I remarked before that the transition was facilitated by the belief in fate, as the god of immutability, to whom the other gods were subordinated more and more as the permanence of natural relations was revealed by accumulated experience. The irresistible conviction of such supremacy was the original and undisputed basis of a new mental *régime*, which has, at this day, become complete for the highest order of minds. The mode of transition can not be questioned if we consider that the Providence of the monotheists is nothing else than the Fate of the polytheists, gradually inheriting and absorbing the prerogatives of all the other deities, and only assuming a more determinate and concrete character, as a more active extension succeeded to the vague and abstract earlier conception. Absolute monotheism, as presented by metaphysical deists,—that is, the doctrine of one supernatural being, without mediators between him and Man,—is a mere abstraction, which can furnish no basis for any religious system of real efficacy, intellectual, moral, or, above all, social. The popular idea of monotheism closely resembles the latest polytheistic conception of a multitude of supernatural beings, subjected directly, regularly, and permanently to the sway of a single will, by which their respective offices are appointed: and the popular instinct justly rejects as barren the notion of a god destitute of ministers. Thus regarded, the transition, through the idea of Fate, to the conception of Providence, is clear enough, as effected by the metaphysical spirit in its growth.

Besides the reasons already assigned for the Greek philosophy having taken the lead, when the rest of the world was ready, we must bear in mind the accordance of the spirit of doubt and intellectual decision with the tendencies of the contemporary social state. The military education of the Greeks, unprovided with an adequate object; the fluctuating state of their polity; and the perpetual contentions among peoples at once alike and mutually repugnant,—were all predisposing causes of the reception of the metaphysical philosophy, which in due time disclosed a congenial career to the Greek mind. It could never have obtained a footing in Rome while a single clear aim absorbed all the powers of the nation; nor did it, when that aim was accomplished. When Rome was mistress of the world, the conflicts of Greek rhetoricians and sophists never excited more than a factitious kind of interest.

From the outset, as I observed before, the metaphysical philosophy contemplated some sort of government of society by mind, under the direction of some metaphysical system or other. This is shown by the convergence of all manner of discordant Utopias toward the same end. But the radical incapacity of metaphysics was so apparent when moral philosophy came to be applied to the conduct of society, that it became necessary to draw toward monotheism, which was the centre of all important speculation, the only basis of the needed union, and the only fulcrum of genuine spiritual authority. Thus we see that in the grandest period of Roman empire, the various philosophical sects were more theologically inclined than for two or three centuries before, busily propagating monotheistic doctrine, as the only intellectual basis of universal association. As science was then only nascent, and metaphysics could organize nothing but doubt, it was necessary to recur to theology, for the sake of its social properties, which were to be cultivated on the monotheistic principle. The Roman sway was favorable to this process, both because it had organized wide intellectual communication, and because it exhibited within its bounds the whole collection of religions in all their barrenness, and thus called for a homogeneous religion such as monotheism; the only one which offered such dogmatic generality as would suit all the elements of this vast agglomeration of nations.

The social aspect of this revolution (the greatest the world has ever seen, except the one in progress) also shows it to be a necessary result of that combination of Greek and Roman influence, at the period of their interpenetration, which Cato so unavailingly opposed. The fact of this combination throws much light on the division of the spiritual and the temporal power, which appears paradoxical till its causes are understood. The speculative ambition of the metaphysical sects impelled them to aim at absolute dominion,—at guiding not only the opinions and morals of men, but their acts and practical affairs, by philosophers, who should have become supreme in authority. It was yet too early for thè conception of a regular division between moral and political government: neither philosophers nor emperors dreamed of it. Thus, philosophy was in perpetual, though latent insurrection against a political system under which all social power was concentrated in the hands of military chiefs. Its professors, the independent thinkers who, without any regular mission, proposed themselves to the astonished but acquiescent public and magistracy as intellectual and moral guides in all the affairs of life, were, in their very existence, a germ of future spiritual power, apart from the temporal: and this is, in a social view, the mode in which Greek civilization participated in bringing about the new state of things. On the other hand, when Rome gradually conquered the world, nothing was further from her thoughts than ever giving up the system which was the basis of her greatness, and under which all sacerdotal power was in the hands of military chiefs: and yet, she contributed her share toward the formation of an independent spiritual power. It happened through her finding the impossibility of keeping together portions of her empire so various and remote by any temporal centralization, however stringent; and, again, by her military activity passing from the offensive to the defensive state, and parting off, for want of central aim, into independent principalities, requiring the advent of the spiritual power, to unite them in a common bond. We shall see that this was the real origin of the feudality of the Middle Ages. A third way was that a universal morality became necessary, to unite the nations, which were brought forcibly together while urged to mutual hatred by their respective forms of polytheism; and the need was met and satisfied by the communication of those higher and more general views and feelings which the conquering nobles had acquired by exercise and proof. In this way it appears that the political movement had as much share as the philosophical in causing that spiritual organization which distinguished the Middle

Ages, and which owed its attribute of generality to the one movement, and that of morality to the other.

The Jews.

As nothing was fortuitous in this great revolution, but, on the contrary, every leading feature might be anticipated after due consideration of the conditions I have indicated, it may be interesting to observe what Roman province must be the scene of the great result of the dualism just described. It must be a portion of the empire which was especially prepared for monotheism, and for the habitual existence of an independent spiritual power. It must have an intense and obstinate nationality, which would make it suffer under isolation, and find a way out of it, without surrendering its peculiar faith, and indeed being disposed to propagate it. These conditions point to the little Jewish theocracy, derived in an accessory way from the Egyptian, and perhaps also the Chaldean theocracy, whence it probably emanated by a kind of exceptional colonization of the sacerdotal caste, the superior orders of which, become monotheists by their own intellectual progress, were led to institute, as a refuge or an experiment, a monotheistic colony, in which monotheism preserved a difficult but avowed existence,—at least, after the separation of the ten tribes. Before the annexation to Rome, this anomalous people was only the more isolated by its faith, through the pride of superiority which enhanced, in their case, the superstition of exclusive nationality proper to all theocracies. This peculiarity was beneficial to the great movement, by furnishing the first direct instruments of the universal regeneration.

This view seems to present itself naturally; but it is not essential to our analysis. If the Jews had not made a beginning, some other nation would have offered the requisite organs; and those organs would have guided the advance in precisely the same direction, only transferring to some books, now probably lost, the sacred character which is still attributed to others.

The slowness of this immense revolution is easily accounted for, if we only consider how all the social powers of the polytheistic *régime* were concentrated, so that it was necessary to change everything almost at once. The theocratic elements of the Roman system were once more in the first rank; for the five or six centuries which intervened between the emperors and the kings may be considered as a vast military episode in the long period proper to ancient theocracies; and the sacerdotal character, which had, for that interval, been effaced by the military, reappeared, when conquest ceased. With the re-establishment of the theocratic *régime*, now much weakened, the conservative instinct proper to it revived, notwithstanding the instability of the rulers after the humiliation of the senatorial caste. This confusion between the temporal and spiritual power, which was the very spirit of the system, explains why even the wisest and most generous of the Roman emperors could no more understand than a Chinese emperor could now, the voluntary renunciation of polytheism, which they regarded, and feared to sanction, as a demolition of their whole government, till the gradual conversion of the population to Christian monotheism introduced a new political influence, permitting first, and then requiring, the conversion of the leaders. That conversion terminated the preparatory progression, and opened the new system by a decisive symptom of the real, independent power of the new spiritual authority which was to be its great moving force.

Such is my view of ancient polytheism as a whole, contemplated in its intellectual and social aspects, and examined as to its tendency to produce the new theological phase of the Middle Ages; which, again, after performing higher social functions than its predecessor, is making way for the advent of the positive philosophy. In the examination of monotheism to which I shall now proceed, I shall be obliged, as hitherto, to content myself with proposing my series of historical views, in illustration of my theory of human development; leaving it to the reader to supply the mass of historical proof which it would be incompatible with the nature and limits of my work for me to set before him.

CHAPTER IX.

AGE OF MONOTHEISM.—MODIFICATION OF THE THEOLOGICAL AND MILITARY SYSTEM.

WHEN Rome had united the civilized world under her sway, the time was come for Monotheism to assume and complete the work of preparation for a new and higher social life. The intellectual decline of the theological philosophy was about to begin: but it had not yet attained its full social value: and this action, inverse to that of the polytheistic *régime*, is the reason why we should consider its social qualities,—beginning with the political, before examining its mental attributes. I begin with the political because though the predominant action of monotheism is moral, its moral efficacy itself has always depended on its political existence. My task will be shortened by a new facility, which will attend us from this point onward,—that of attending to one form only of the theological *régime*. Hitherto, we have had to separate the abstract qualities of the system examined from the various modes in which they were realized. Now, we have to attend only to the Roman Catholic form of monotheism, because, while Mohammedanism, the Greek faith, and every other form of monotheism, presents a remarkable general conformity with all the rest, it is the Roman Catholic form which has fulfilled the functions of the *régime* in Western Europe: and it must therefore be the single object of our examination. I prefer the term Catholicism to that

Catholicism the form.

of Christianity, not only because it is more distinctive, but because it is more universal, from involving no name of any individual founder, but comprehending the monotheistic principle without sectarian limitation. Every one knows what a Catholic is; but the wisest man will not undertake to say what a Christian is, now that the title belongs to all the thousand varieties which separate the primitive Lutheran from the pure deist.

As the chief attribute of the political system of monotheism is the introduction of a spiritual power independent of the temporal, we must first examine this great social creation, passing on afterward to the temporal organization.

The uniformity of belief proper to monotheism, and enforced by it, admits of the establishment of a single theological system among peoples too important and too diverse to be long kept together under one temporal government: whence such a consistence and dignity must accrue to the sacerdotal class as affords a ground for political independence. The preparation of the conditions, beginning from the concurrence of the Roman power with the Greek philosophy, was very slow. The Greek philosophy, it is true, contemplated the establishment of a spiritual power; but it did not contemplate the separation of the temporal power from it: hence it merely indicated, as every Utopia does, the social need of the age, and prophesied its satisfaction: and it remained for Catholicism to take to itself whatever was true and practicable in all other schemes, dismissing what was foolish or hurtful. How this was done we shall see as we proceed.

Principle of political rule.

Though intelligence must always exert a powerful influence in human affairs, and though a certain convergence of opinion is necessary to all association, and therefore to all government, such supremacy of intellect in political government as the Greek philosophers desired can never be more than a dream. The intellectual life is feebler than the affective in our organism, as I have repeatedly said; and mental superiority is too little understood and appreciated by the majority of society to obtain an immediate and practical ascendency. The mass of mankind, being destined to action, sympathize most with organizations of moderate intelligence and eminent activity. The general gratitude also waits upon services which satisfy the sum of human wants, among which those of the intellect are very far from holding the most conspicuous place. The most vivid interest and the most unqualified gratitude are excited by practical success, military or industrial, though such achievement requires far less intellectual power than almost any theoretical labors, even of a kind very inferior to the highest speculations in art, science, and philosophy. Though these speculative services are the loftiest of benefits, and the very means of progress, they can not awaken the rapid and ready enthusiasm excited by far inferior operations: for mental participation in them is too remote and too abstract to be obtained otherwise than through a more or less difficult analysis, which is not favorable to sudden fervor, even among enlightened men. Even in the regions of science and philosophy, the most general conceptions bring less honor to their illustrious creators than discoveries of an inferior order, as an Aristotle, a Descartes, and a Leibnitz had only too much reason to know. The value of such men is not recognized till their mission has closed ; and they are sustained in their labors, not by an immediate supremacy (which would be sure, under a reign of mind, to be seized by the boldest pretenders), but by their secret consciousness of their intellectual rank, and their instinctive assurance of their ulterior influence on human destiny. And then, again, there is the shortness of our life, on which I remarked before as injurious to our political organism. A greater longevity might allow a better social classification of intellect, by affording more time for the recognition of choice minds ; but at present the cases are extremely rare of thinkers of the first order being appreciated till their life, or their genius, has passed away. The sacerdotal sway under the old theocracies may seem to be a contradiction to what I have now said ; but, besides that the case was an anomalous one which can never recur, as the beginning of a new system can happen but once, we must remember that the intellectual superiority of the governing power showed itself in a practical form. From the singular concentration of functions in the priestly caste, their speculative labors, which were seldom greater than occasion required, were professedly and complacently subordinated to practical use, whether medical, administrative, industrial, or any other. Thus it was not intellectual superiority that was raised to supremacy : and it could not be so in a society organized by the hereditary principle. It was among the Greek philosophers that the speculative character first became distinctly marked ; and we know how far it was, amid all its strenuous efforts, from ever obtaining political sway. It is plain, on every ground, that the real social office of mind is not to engross the conduct of life, but to modify, by its consultative or preparatory influence, the rule of material or practical power, whether military or industrial : and no complaints on the part of philosophers will affect an order of things which, being natural, must be most in harmony with social conditions. The direct consideration of utility is so narrow that it would be oppressive and dangerous in action if unmodified ; but not the less is it the basis of all sound social classification. In social as in individual life, judgment is more necessary than genius, except on the rare occasions when a new elaboration or special animation of the mass of social thought is required. Then some few eminent thinkers interpose to conduct the crisis, and set forward the ordinary movement again for another long period. It will be seen, if we inquire, that in every instance of the appearance of any great new social phase, simple good sense, after having given place for a time, quietly resumes its social sway ; and the more fit abstract speculation is to conduct such crises, the less adapted is it for the daily direction of common affairs. Intellectually, contemplative minds are unprepared for special and pressing calls on their activity; and morally, they can not take a sufficient interest in the obtrusive and detailed reality with which il is the business of government to deal. Again, they are led away by their interest in some special study from that consideration of the whole which is the first attribute of good government; and when a decision is required which can not be sound unless it rests upon a balance of social views, the philosopher will be found remotely pursuing his abstract study of one single social aspect. The very few who are able to keep the whole in view while pursuing their own order of speculation are precisely those who are furthest from desiring to rule society, because they best know how mischievous the aim would be if it were not impracticable. Mankind can not therefore too eminently honor those noblest minds which devote themselves to think for the whole race; mankind can not too carefully cherish these, its chief treasures and adornments, nor too eagerly support their functions by administering all possible facilities, and laying society open to their vivifying influence; but it should, at the same time, carefully avoid committing the ordinary direction of society to men whose characteristic qualities render them essentially unfit for the task. We must remember, too, how indispensable constant stimulus is to this least active part of human nature, which needs opposition to rouse it to work. Mind is made for conflict, and not for rule, and it would sink into fatal atrophy from the moment when, instead of having to modify an order independent of itself, it should indulge in admiration of an order of its own creation and appointment. From that moment it would follow the conservative course of theocratic government; and we have seen what that is. It is needless to point out that by this time it would not be the first-rate minds that would be in the seats of power, but inferior thinkers, who, with the lower morality which belongs to their combined intellectual and social rank, would use their power to maintain their position. Envying and hating the superiors whose honors they usurped, and repressing the mental development of the mass of the people, these pretended intellectual princes would, if their reign were possible, teach us how incompatible with order and progress is a nominal reign of Mind. If the ruling powers of the civilized world have not, in fact, systematically hindered the expansion of the human mind, it is (for one reason among others) because they did not suppose mental superiority to be any qualification for political rule, and were therefore not afraid to encourage its spread.

This seems to be a long digression; but I have pursued it designedly, not only because it seems to me to be called for by some circumstances of our times, but because we shall find it a valuable preparation for our dynamic studies, saving the necessity of various elucidations which would otherwise be called for. I may add that it may obviate some natural though baseless fears of a sort of theocratic despotism, such as might otherwise be entertained when we propose the idea of an intellectual reorganization of the political system of modern society. It enables us, on our return to our proper historical ground, to estimate the difficulty which the monotheistic system had to surmount, in the Middle Ages, in forming the new social constitution of the most advanced portion of the human race.

The great problem.

The great political problem was to discard the dreams of Greek philosophy about the sovereignty of intellect, while satisfying the irresistible desire for social ascendency entertained by the speculative activity of a long course of generations. The new power had been in a state of latent insurrection under the Greek, and also the Roman *régime;* and it was now necessary, under pain of an eternal and fatal conflict between the men of action and the men of thought, to organize some permanent reconcilation, which should convert this vicious antagonism into a useful emulation, assigning to each great force a share in the political system—a participation independent while convergent, and enjoyed in virtue of prerogatives naturally inherent in each. This was the vast difficulty encountered by Catholicism in the Middle Ages, and admirably surmounted by means of that fundamental division between the spiritual and the temporal authority which will be more and more recognized as the greatest advance ever made in the general theory of the social organism, and as the main cause of the superiority of the modern to the ancient polity. No doubt the solution was empirical at first; and it was not till long afterward that its true philosophical conception was wrought out of the experience of the facts; but such has been the process with all great political issues, because a rational political science, qualified to guide and enlighten the gradual course of actual operations, has never yet existed. The character and efficacy of this great act of progress were also impaired by its connection with the provisional destiny of the theological philosophy, even then on the decline: and this connection is, in fact, the main cause of the repugnance which modern minds are apt to feel, in a temporary way, toward the distribution of power which, once affected under any form, will remain—whatever may become of its first philosophical basis—and prevail even in the minds to which it was once most unacceptable, till, philosophically reconstructed, it becomes the grand foundation of modern reorganization. It is clear, moreover, that the theological aim of the speculative class must have seriously injured their social function; because their intellectual and even their moral functions must have been insignificant in comparison with their charge of the faith, and all social direction of minds and hearts uninteresting in comparison with the salvation of souls. Again, the almost indefinite authority possessed by the exclusive interpreters of the divine will and judgments were favorable to abuse, and even vicious usurpation, such as was only too congenial to ecclesiastical power, through its natural ambition, and the vague and absolute character of its essential doctrines, which proposed no rational

Separation of spiritual and temporal power.

limitation of the various kinds of human authority. These evils hastened the decline of the constitution to which they belonged, and they troubled the process of the true distribution of power; but they did not ruin it. They did not prevent its aiding the contemporary progression of the race, nor its establishment as a precedent for the future improvement of the social organism; these being the two aspects in which we have now to examine it. It is incompatible with the limits of this Work to give such an account of the economy of the Catholic system of the Middle Ages as could convey any idea of the profound admiration I entertain for it; but it is the positive philosophy which will first render justice to this greatest political achievement of human wisdom. Hitherto it has been examined by panegyrists, who were necessarily under a sort of fanatcism on the subject, or by blind detractors, who saw nothing of its social destination. The positive philosophy, as free from monotheistic as from polytheistic or fetich belief, can be equally impartial in all the case, and, being provided with a theory, can judge of the participation of Catholicism in human progress, in the way that institutions, like men, can alone be truly judged: that is, after the full accomplishment of their principal mission.

Transposition of morals and politics. We have seen that hitherto morals had always been subordinated to political considerations. The grand social characteristic of Catholicism was that by constituting a moral power, wholly independent of the political, it infused morality into political government; and this was done so naturally in the course of human progress, that it has survived the decay of the system which was its first organ; and with such vigor, that it marks, amidst all fluctuations, and more than any other characteristic whatever, the radical superiority of modern civilization over that of antiquity. From the outset, this new power took up a position equally remote from the foolish political pretensions of the Greek philosophy, and the degrading servility of the theocratic spirit, prescribing submission to established governments, while subjecting these governments to a universal morality of growing strictness. Whether, as at first, under Roman sway, or, as afterward, under that of the forces of the North, it certainly aimed at nothing more than modifying by moral influence a pre-existing and independent political power. If the conflicts between the two powers which abounded so much in the Middle Ages are duly examined, it will be found that they were almost defensive on the part of the spiritual power, which had to contend, and did contend nobly, though often with only partial success, for the independence which was necessary to the discharge of its mission. The tragical story of Thomas à Becket, with a multitude more, less famous in history, proves that the aim of the clergy in such conflicts was to guard their choice of their own functionaries from temporal usurpation; a pretension which must be admitted to be legitimate and modest enough. Any

Function of each. rational theory about the boundaries of the two powers must, it seems to me, rest on the general principle that as the spiritual power relates to *education*, and the temporal one to *action*, the influence of each must be sovereign in its own department, and only consultative in that of the other. Thus, the function of the spiritual power is, in the first place, to educate, according to the ordinary sense of the word, and then to keep up and apply, in the social practice of individuals and classes, the principles which education had prepared for the guidance of their life. As to still wider, even international relations, by which this power was chiefly characterized in the Middle Ages, they were simply an extension of the same operation to peoples so remote and so various as to require distinct and independent temporal government; and which would therefore have been without any regular political connection if the spiritual power, equally at home among all nations, had not employed its universal privilege in arbitrating in all their disputes, and, on occasion, promoting their collective activity. When once we have summed up all its prerogatives under the principle of Education, which enables us to take a single comprehensive view of the whole vast organism, we shall be so far from imputing to the Catholic power any serious usurpation of temporal authority, that we shall admit that it rarely obtained such freedom of action as was essential to the proper accomplishment of its mission, even in the days of its greatest splendor,—from about the middle of the eleventh to the end of the thirteenth century. Through all obstacles, however, Catholicism fulfilled its great provisional office, giving to the world, by its mere existence, an example which will never be lost of the inestimable influence on the improvement of society of a genuine spiritual authority, such as we have need of now, and shall obtain, when we have ascertained an intellectual basis for it, more direct, broader, and more durable than that of Catholicism.

The speculative class.

It was under Catholicism that the speculative class began to assume the character assigned to it by the immutable laws of human nature, neither engrossing political sway, as in theocracies, nor remaining outside of the social organization, as under the Greek *régime*. Henceforth its post was one of calm and enlightened, but not indifferent observation of practical life, in which it could interpose only in an indirect manner, by its moral influence. Thus placed at the true point of view of the general economy, being the spontaneous, faithful organ, and the natural adviser of its needs, it was eminently adapted, by speaking to each in the name of all, to introduce into the active life of individuals, classes, and nations, the abstract consideration of the common good, which would otherwise have been effaced amidst the divergences and discordance of the activity of the age. From this memorable period, a regular division between theory and its application began to be established, in the case of social ideas, as it had already been, with more or less success, in the case of simpler conceptions: political principles were no longer empirically constructed as required by practical urgency: social necessities came to be wisely considered in advance; and a legitimate expansion was afforded to the spirit of social, and even of political improvement: in short, political action began to assume, in its intellectual relations, a character of wisdom, extent, and even rationality, which had never existed before, and which would have been more marked already but for the misfortune that the philosophy involved in the operation was the theological. Morally regarded, there can be no doubt that this modification of the social organism developed among even the lowest ranks of the nations concerned in it a sense of dignity and elevation before almost unknown: for the universal morality, thus established by general conviction outside of and above the political sphere of action, authorized the meanest Christian to adduce, on occasion, to the most powerful noble, the inflexible prescriptions of that common doctrine which was the basis of obedience and respect; an obedience and respect which were now due to the function, and no longer to the person; so that submission might henceforth cease to be servile, and remonstrance to be hostile. In a purely political view, this happy regeneration realized the great Utopia of the Greek philosophers, in all that was useful and reasonable, while excluding its follies and extravagances; since it constituted, in the midst of an order founded upon birth, fortune, or military valor, an immense and powerful class in which intellectual and moral superiority was openly entitled to ascendency, and often led to the most imminent positions in the heirarchy; so that the same capacity which would have been disturbing or oppressive according to Greek notions, thenceforth became the ordained guide of the general progress: a settlement so satisfactory that we have only to follow its lead in reconstructing the same system on a better foundation. In the internationai view, we can not but perceive the aptitude of the spiritual organization for an almost indefinite territorial extension, wherever there was an analogous civilization admitting of a system of continuous relations, while the temporal could not, from its very nature, transcend its much narrower limits, without such intolerable tyranny as induced its own destruction. The papal heirarchy, in fact, constituted, in the Middle Ages, the main bond among the various European nations, after the decline of the Roman sway: and, in this view, the Catholic influence ought to be judged, as De Maistre truly remarked, not only by the ostensible good which it produced, but yet more by the imminent evil which it silently obviated, and which, on that account, we can only inadequately appreciate. If we measure the value of such an organization by the Catholicity from which it derives its title, we shall find that it allows us, better than any other, to estimate both the superiority and the imperfection of Catholicism in comparison with the system which preceded and with that which must follow it. For, on the one hand, the Catholic organization, extending to India and America, embraced an extent of territory and population far exceeding that of the Roman dominion, which became unmanageable by the disjunction and remoteness of its extremities from its active centre; and, on the other hand, Catholicism could incorpo-

The Catholic system.

rate with itself, in the days of its greatest splendor, only a small portion of the civilized world; since, before it was matured, the Mohammedan monotheism had taken possession of a large portion of the white race; and, some centuries afterward, the Byzantine monotheism, which was almost as unlike it, had alienated from it for ever the half of the Roman world. These restrictions, so far from being accidental, must be philosophically regarded as an inevitable consequence of the vague and arbitrary character of theological belief, which, while laboriously organizing a dangerous but temporary intellectual repression, could never occasion a satisfactory mental convergence among numerous and remote peoples, which can enter into durable communion only through a purely positive philosophy, amidst any possible elevation of the human race.

Having thus ascertained the social destination of the Catholic power, we must next briefly review the conditions of that action by which it achieved the moral results that remain imperishable after the decay of its intellectual basis.

Ecclesiastical organization.

These conditions naturally divide themselves into the two classes of statical and dynamical conditions; the first class relating to the proper organization of the Catholic hierarchy; and the other to the accomplishment of its destination. Taking the statical conditions first—we can not be surprised at the universal political ascendency of the ecclesiastical organization in the Middle Ages, superior as it was to all that surrounded it, and to all that had preceded it. Directly based upon intellectual and moral desert, at once flexible and stable, connected in all its chief parts, without repressing the proper activity of any, this admirable hierarchy could not but inspire in the humblest of its worthy members a sense of superiority, just, though sometimes too haughty, toward the ruder organisms with which it was at first connected, and which rested chiefly on birth, modified by fortune or military ability. When it took its true form, the Catholic organization, on the one hand, extended the elective principle by admitting to choice of office the whole of society, the lowest ranks of which have supplied cardinals, and even popes; and, on the other hand, it advanced the nature of this political principle by reversing the order of election, by causing the superiors to be chosen by the inferiors. The characteristic method of election to the supreme spiritual dignity must ever, it seems to me, be regarded as a masterpiece of political wisdom, in which the guarantees of stability and due preparation must be more secure than they could be by the empirical expedient of hereditary succession, while the soundness of the choice must be favored both by the superior wisdom of the well-adapted electors, and by the careful encouragement given to the capacity, wherever found, for ecclesiastical rule, proved by an active noviciate; these collective precautions being in full accordance with the extreme importance of the eminent function which Catholic philosophers have ever justly regarded as the nucleus of their ecclesiastical system.

Elective principle.

We must also recognise the political bearing of the monastic institutions, which, apart from their intellectual services, certainly were one of the most indispensable elements of the vast organism. Monastic institutions. Arising out of the urgent need which, in the early days of Catholicism, was felt by contemplative minds to disengage themselves from the excessive dissipation and corruption of contemporary society, these special institutions, which we now know chiefly through the abuses of their declining period, were the cradle whence issued by anticipation the chief Christian conceptions, dogmatic and practical. Their discipline became afterward the permanent apprenticeship of the speculative class, and the foundation whence issued the reformation of orders; a provision for the beneficial exercise of political genius which it has been impossible to appreciate, since the inevitable decay of this vast provisional system of spiritual organization. It is clear that the Catholic system could not have preserved, among its European relations, the attri, bute of generality, secure from absorption by the spirit of nationality inherent in its local clergy, if these contemplative train-bands, who were placed by their very nature at the universal point of view had not been for ever reproducing direct thought, while exhibiting an example of independence which thereby became more generally practicable.

Special education of the clergy. The chief condition of efficacy common to all the political qualities of the Catholic constitution was the powerful special education of the Clergy, which rendered the ecclesiastical genius habitually superior to every other, not only in knowledge of all kinds, but in political aptitude. The modern defenders of Catholicism, while proving that this education was always kept up to the most advanced point of general philosophy, have overlooked the importance of the introduction into that education of the new element of History, which, at least in the form of the history of the Church, became a part of ecclesiastical study. If we consider the filiation which connected Catholicism on the one hand with the Roman, and on the other with the Greek *régime*, and even through Judaism, with the most ancient theocracies; and again, if we remember its continuous intervention in all great human affairs, we shall see that, from the time of its full maturity under the great Hildebrand, the history of the Church was a kind of fundamental history of humanity, in its social aspect. Whatever was narrow in this view was compensated for by the unity of conception and composition which belonged to it, and which could not have been otherwise obtained: so that it should be no surprise that the philosophical origin of universal historical speculation is due to the genius of modern Catholicism. Taking for granted the political superiority which must have belonged to disciplined and meditative thinkers in the midst of an ignorant temporal aristocracy, who cared for nothing else in history than the genealogy of their houses, or some provincial or national chronicles, we may further admit that the prerogative still rests where it did, for want of being claimed by any other body. Amidst the intellectual and social decay of Catholicism, we shall probably find, in the higher ranks of its hierarchy, more minds than we can find elsewhere which are capable of assuming the true point of view of human affairs as a whole, though the political destruction of their corporation prevents their manifesting, or perhaps cultivating the quality.

Restriction of inspiration.

One more quality of their political philosophy, hitherto unnoticed, remains to be pointed out;—I mean the discipline by which Catholicism, in the days of its greatness, diminished the political dangers of the religious spirit by restricting more and more that right of supernatural inspiration which no theological system can dispense with entirely, but which the Catholic organization reduced, and shackled by wise and powerful ordinances, the importance of which can be understood only by a comparison with the preceding, and in some sort, with the following state. Polytheism was never at a loss for a deity to protect some inspiration or other; and though monotheism reduced its extent, and modified its exercise, it still allowed a dangerous scope to inspiration, as we see by the case of the Jews, among whom prophets and seers abounded, and had even a certain recognized though irregular function. Catholicism, as the organ of a more advanced state, represented the privilege of inspiration as eminently exceptional, limiting it to instances more and more serious, to fewer and fewer chosen persons, at more and more distant intervals, and subjecting it to tests of growing severity; and it reached its last degree of possible restriction when divine communications were generally reserved for the supreme ecclesiastical authority exclusively. This papal infallibility, which has been regarded as such a reproach to Catholicism, was thus, in fact, a great intellectual and social advance. As De Maistre observed, it was simply the religious condition of the final jurisdiction, without which society would have been forever troubled by the inexhaustible disputes generated by such vague doctrines. It will at once occur to the thoughtful observer that we find here a striking confirmation of the great proposition of historical philosophy before laid down, that, in the passage from polytheism to monotheism, the religious spirit underwent an intellectual decline; for we find Catholicism constantly employed in actual life in extending the domain of human wisdom at the expense of that, once so vast of divine inspiration.

I can not afford space to dwell on the special institutions of Catholicism, however great their importance in the working of the organism; such, for instance, as the employment of a kind of sacred language, by the preservation of Latin in a sacerdotal corporation, when it was no longer the popular language; a means of facilitating communication and concentration, within and without, and also of putting off the inevitable day when the spirit of individual criticism should attack the noble social edifice, whose intellectual bases were so precarious. But there are still two eminent conditions, the one moral and the other political, which, without being so essential as those I have just noticed, are yet indispensably connected with Catholicism. Both were ordained by the special nature of the period and the system, rather than by the general nature of the spiritual organization: a distinction which is important to their clearness and relevancy in this place. They are, the institution of ecclesiastical celibacy, and the annexation of a temporal principality to the centre of spiritual authority, in order to secure its European independence.

Ecclesiastical celibacy.

The institution of ecclesiastical celibacy, long repressed, but at length established by the powerful Hildebrand, has ever been justly regarded as one of the essential bases of sacerdotal discipline. Its favorable influence on the performance of spiritual and social functions, in a general way, is well understood; and, with regard to Catholicism in particular, it is seen to be necessary to the common discharge of the chief moral offices of the clergy, especially confession. In a political view, we have only to imagine a state of society in which, without celibacy, the Catholic hierarchy could certainly never have acquired or maintained either the social independence or the freedom of mind necessary to the accomplishment of their great provisional mission. The hereditary principle was still prevalent and in vigor, everywhere but in the ecclesiastical organization; and the clergy would have been drawn away by it, but for the institution of celibacy. Whatever nepotism there was, was exceptional; but there was enough to show what would have been the consequence if the division of the two social powers had been put to risk by such a transmutation as the popes found it so difficult to restrain, of bishops into barons, and priests into knights. We have never done justice to the bold and radical innovation wrought by Catholicism in the social organism, when it superseded the hereditary principle in the priesthood, which was incorporated with the social economy, not only of theocracies, but of the Greeks and Romans, among whom pontifical offices of importance were the exclusive patrimony of some privileged families, or at least of a caste. The great political service of Catholicism in aiming this fatal blow at the system of caste is a sufficient evidence how far it was in advance of the society on which it had to operate. Yet the blind opponents of Catholicism may be seen to confound the Catholic *régime* with the ancient theocracies, while reproaching it with that ecclesiastical celibacy which renders pure theocracy impossible by guarantying a legitimate access to sacerdotal dignities for all ranks of society.

Temporal sovereignty of the Popes.

As for the temporal sovereignty of the Head of the Church,—it must not be forgotten that the Catholic system arose at a time when the two powers were confounded, and that it would have been absorbed or politically annulled by the temporal power, if the seat of its authority had been included in any particular jurisdiction, whose lord would presently, after the manner of his time, have humbled the pope into a sort of chaplain: unless, indeed, we resort to the artless supposition of a miraculous succession of Charlemagnes, sagacious, like him, to discern the true spirit of European organization in the Middle Ages, and therefore disposed to respect and guard the independence of the pope. Though monotheism favored the separation of the two powers, it could not be with such energy and precision as would enable it to dispense with the aid of political conditions: and of these the most evident and important was the possession of a territorial sovereignty, containing a population which might be provisionally sufficient to itself, and which might thus offer a secure refuge to all members of the vast hierarchy, in case of collision with the temporal powers which, but for such a resource, would have held them in close local dependence. The seat of this exceptional principality was hardly a matter of choice. The centre of the authority that was henceforth to rule the civilized world must be in that one city in which alone the ancient order merged without interruption into the modern, by means of the rooted habits which for long ages had directed thither the social ideas and hopes of the human race. De Maistre has shown us how, in the famous removal to Byzantium, Constantine fled morally before the Church, no less than politically before the barbarians. The necessity of this temporal appendage to the supreme spiritual dignity must not however make us forget the serious evils arising from it, both toward the sacerdotal authority itself, and for the portion of Europe set apart to be this political anomaly. The purity, and even the dignity of the pontifical character were compromised by the permanent incorporation of the lofty prerogatives of the papacy with the secondary operations of provincial government. Through this very discordance, the popes have ruled so little in Rome, even in the most splendid period of Catholicism, as to have been unable to repress the factions of great families, whose disgraceful conflicts so often defied and injured the temporal authority of the papacy. Italian ambition had at first favored the papal system; but in this way it helped to disorganize it; and the spiritual Head of Europe is now seen transformed into a petty Italian prince, elective while his neighbors are hereditary, but occupied, just as they are, and even more than they, with the precarious maintenance of his local dominion.* As for Italy at large, her intellectual and even moral development was accelerated by such a settlement; but she lost her political nationality by it: for the popes could neither pervert their function by including all Italy under their temporal rule, in defiance of Europe; nor, from a regard to their own independence, permit any other great Italian sovereignty to border upon their territory. There was no more deplorable consequence of the condition of existence that we have just reviewed than the political sacrifice of so valuable and so interesting a part of the European community, which has been fruitlessly struggling, for ten centuries, to establish a national unity incompatible with the political system founded upon Catholicism.

These statical conditions of the political existence of Catholicism

* Published in 1841.

have been noticed with so much distinctness, because they are open to misconception when the philosophical principle of interpretation is not laid hold of. The dynamical conditions may be more briefly dismissed. We have little more to consider than the great elementary prerogative of Education,—using the word in the large sense before assigned to it.

Educational function.

If we were philosophical enough to judge of the Catholic system of universal ministration, not by the backward character of Catholic education in the present day, but by what it was in comparison with the preceding state of things, we should better estimate its importance. The polytheistic *régime* doomed the mass of society to brutish stupidity: not only slaves but the majority of free men being deprived of all regular instruction, unless we may so call the popular interest in the fine arts and observance of festivals, finished off with scenic sports. Military education, in which free men alone could share, was in fact the only one in ancient times that could be appropriately organized. Vast, then, was the elementary progress when Catholicism imposed on every disciple the strict duty of receiving, and as far as possible, of procuring that religious instruction which, taking possession of the individual from his earliest days, and preparing him for his social duties, followed him through life, keeping him up to his principles by an admirable combination of exhortations of exercises, and of material signs, all converging toward unity of impression. In an intellectual view, the philosophy which formed the basis of popular catechisms was all that it could be in those times,—all that existed except the metaphysical teachings, which were radically unfit, from their anti-organic nature, to enter into general circulation, and which could only have engendered a prevalent skepticism. The rudiments of science, discovered in the school of Alexandria, were too weak, disconnected, and abstract, to enter into popular education, even if they had not been repelled by the spirit of the system. So far from the Catholic system having always been repressive of popular intelligence, as is now most unjustly said, it was for a long period the most efficacious promoter of it. The prohibition of the indiscreet and popular use of the Scriptures was a logical necessity imposed by the view of giving an indefinite continuity to monotheism; and, injurious as are the intellectual and social consequences of such a prohibition, it can not be philosophically regarded as a step backward toward theocracy: for, so far from favoring the monopoly of knowledge and power which distinguished theocracy, the Catholic clergy were for ever laboring to imbue the whole of society with whatever knowledge they had themselves obtained. This was indeed a necessary consequence of the division of powers, which left no other sufficient support for the spiritual authority than the intellectual development of society. Our estimate of the mental and moral operation of the Catholic educational system will come in better hereafter; and our present business is with its political operation only. The political influence of the priesthood arose out of the natural ascendency which accrues to the original directors of all education that is not confined to mere instruction; an immediate and general ascendency, inherent in that great social office, quite apart from the sacred character of spiritual authority in the Middle Ages, and the superstitious terrors which were connected with it. Furnished from the beginning with the empirical wisdom of the Eastern theocracies and the ingenious speculations of the Greek philosophy, the Catholic clergy had to apply themselves to the steady and accurate investigation of human nature, individual and social; and they made as much progress in it as was possible by means of irrational observations, directed or interpreted by theological or metaphysical conceptions. Such knowledge, possessed in the highest existing degree, was eminently favorable to political ascendency, because it naturally and at all times constitutes the chief intellectual basis of spiritual authority; all other sciences operating merely, in this relation, through their influence on speculation that regards Man and society. The institution of Confession is an all-important function of the prerogative of Education. It is at once a consequence and a complement of it. For it is impossible, on the one hand, that the directors of youth should not be the counsellors of active manhood; and, on the other, that the social efficacy of their early influence should be secure without such a protraction of moral influence as would enable them to watch over the daily application of the principles of conduct which they had instilled. There can be no stronger proof of the decay of the old spiritual organization than our present inability to see the necessity of such a function, and to feel its adaptation to those primary needs of our moral nature, effusion and direction, which, in the first instance, could not be better satisfied than by the voluntary submission of every believer to a spiritual guide, freely chosen from a vast and eminent corporation, all whose members were usually fit to give useful advice, and incapable, from their disinterested position, of abusing a confidence on which their personal authority was founded. If such a consultative influence over human life were denied to the spiritual power, what social prerogative would remain that might not be more justly contested? The moral of effects of this noble institution, which purified men by confession and rectified them by repentance, have been so effectually vindicated by those who understand them best, that we may spare ourselves any elaborate comparison of it with the rough and ineffectual discipline, equally precarious and vexatious, by which the magistrate, under the polytheistic system, strove to regulate morals by arbitrary precepts, in virtue of the confusion of powers which then prevailed. We have to regard it now only as an indispensable condition of spiritual government, furnishing the information and the moral means without which it could not perform its social office. The evils which it produced, even in its best days, are attributable less to the institution itself than to the vague and absolute nature of the theological philosophy on which the spiritual organization was founded. The right of absolution, almost arbitrary under the best securities, arose necessarily out of this position of circumstances; and no remonstrances could avail against the practical need of it; for without it, a single serious fault must have perpetually occasioned despair, the consequences of which, to the individual and to society, must have converted this salutary discipline into a source of incalculable disturbance.

Dogmatic conditions.

From the political estimate of Catholicism, we must next pass on to a brief review of its dogmatic conditions, in order to see how secondary theological doctrines, which appear to us socially indifferent, were yet necessary to the political efficacy of a system so complex and factitious that when its unity, laboriously maintained, was once infringed by the destruction of any one of its component influences, the disorganization of the whole was, however gradual, absolutely inevitable.

The amount of polytheism involved in Catholicism was as small as the needs of the theological spirit would at all admit. But there were accessory dogmas which, derived more or less spontaneously from the characteristic theological conception, have expanded into means more or less necessary to the fulfilment of its destination in regard to social progress. We must notice the most important of these.

The vague and variable tendency of theological conceptions impair their social efficacy by exposing the precepts they supply to perpetual modification by human passions: and this difficulty can be met only by an incessant vigilance on the part of the corresponding spiritual authority. Catholicism had no choice, if the unity of its social function was to be preserved, but to repress the irreconcilable outbreaks of the religious spirit in individual minds by setting up absolute faith as the first duty of the Christian, because there was no other basis for moral obligation of other kinds. This was a real advance of the moral interests of society; for the great practical utility of religion in that age was that it permitted the provisional elevation of a noble speculative body, eminently adapted during its ascending period to direct the opinions and morals of mankind. It is from this point of view that the dogmatic, as well as the directly political character of Catholicism ought to be judged; for in no other way can we seize the true character of some doctrines, dangerous no doubt, but imposed by the nature or the needs of the system; and in no other way can we understand the importance formerly attributed by so many superior minds to special dogmas which might at first appear useless to the final destination, but which had a real bearing both upon the ecclesiastical unity and social efficacy of Catholicism. Some of these dogmas were the very means of the destruction of the system, by the mental and moral insurrection which they provoked.

Dogmas of exclusive salvation.

For instance, the dogma that the reception of the Catholic faith is the sole means of salvation was the only instrument for the control of theological divergence; but this fatal declaration, which involves the damnation of all heretics, involuntary as well as wilful, excited more deep and unanimous indignation than any other, when the day of emancipation arrived; for nothing is more confirmatory of the provisional destination of all religious doctrines than their gradually leading on to the conversion of an old principle of love into a final ground of insurmountable hatred; as we should see more and more henceforth amidst the dissolution of creeds, if their social action did not tend finally toward a total and common extinction. Of the Fall. The dogma of the condemnation of mankind through Adam, which is, morally, more revolting than the other, was also a necessary element of the Catholic philosophy, not only for the theological explanation it supplied of human suffering, but, more specially, because it afforded ground for the scheme of redemption, on the necessity of which the whole economy of the Catholic faith is based. Of purgatory. The institution of purgatory was happily introduced into the social practice of Catholicism, as a necessary corrective of the eternity of future punishment; for without it, there must have been either fatal relaxation or uncontrollable despair,—both alike dangerous to the individual and society; whereas, by this intermediate issue both were avoided, and the religious procedure could be exactly adapted to each case. This was a case of political necessity; and another, yet more special, is that of the assignment of an absolutely divine character to the real or ideal founder of this great system, through the relation of such a conception to radical independence of the spiritual power, which is thus at once placed under an inviolable authority of its own, direct though invisible: whereas, under the Arian hypothesis, the temporal power, addressing itself immediately to a general Providence, must be less disposed to respect the intervention of the sacerdotal body, whose mystic head has been much lowered in rank. Of Christ's divinity. We cannot imagine, at this day, the immense difficulties of every kind that Catholicism had to encounter in organizing the separation of the two authorities; and therefore we can form no judgment of the various resources required by the struggle; among which resources this apotheosis is conspicuous, tending as it did to raise the Church in the eyes of monarchs; while, on the other hand, a rigorous divine unity would have favored, in an inverse way, too great a concentration of the social ascendency. We accordingly find in history a varied and decisive manifestation of the obstinate predilection among the kings in general for the heresy of Arius, in which their class instinct confusedly discerned a way to humble the papal independence and to favor the social sway of temporal authority. Of the Real Presence. The same political efficacy attached to the doctrine of the Real Presence, which, intellectually strange as it is, is merely a prolongation of the preceding dogma. By it, the humblest priest is invested with a perpetual power of miraculous consecration, which must give him dignity in the eyes of rulers who, whatever might be their material greatness, could never aspire to such sublime operations. Besides the perpetual stimulus thus administered to faith, such a belief made the minister more absolutely indispensable: whereas, amidst simpler conceptions and a less special worship, temporal rulers might then, as since, have found means to dispense with sacerdotal intervention, on condition of an empty orthodoxy. If we proceeded from the dogma to consider the Catholic worship in the same way, we should find that (apart from the moral instrumentality in regard to individual and social action which it afforded) it had the same political bearing. The sacraments, in their graduated and well-combined succession, roused in each believer, at the most important periods of his life, and through its regular course, the spirit of the universal system, by signs specially adapted to the character of each position. In an intellectual view, the mass offers a most unsatisfactory spectacle, appearing to human reason to be merely a sort of magical operation, terminated by the fulfilment of a pure act of spirit-raising, real though mystical: but in a social view, we see in it a happy invention of the theological spirit, suppressing universally and irrevocably the bloody sacrifices of polytheism, by diverting the instinctive need of sacrifice which is inherent in every religious *régime*, and which was in this case daily gratified by the voluntary immolation of the most precious of imaginable victims.

Worship.

What I have said may suggest some conception of the importance of attending to the dogma and worship of the Catholic church in considering its operation on the destiny of society. The more closely we study Catholicism in the Middle Ages, the better we shall understand the interest of the controversies amidst which minds of a high order built up the wonderful organization of their church. The indefatigable labors of so many scholars and pontiffs in opposition to Arianism, which would have destroyed their sacerdotal independence; their struggles against Manicheism, which threatened the very basis of their economy, by substituting dualism for unity; and many other well-known controversies, had as serious and profound a purpose, even of a political kind, as the fiercest contests of our time, which may perhaps appear hereafter quite as strange to philosophers who will overlook the serious social interests involved in the ill-conceived questions that at present abound. The slightest knowledge of ecclesiastical history will confirm the suggestion of philosophy that there must have been some grave meaning in controversies pursued through many centuries by the best minds of the time, amidst the vivid interest of all civilized nations: and there is truth in the remark of Catholic historians, that all heresies of any great importance were accompanied by serious moral or political error,—the logical filiation of which it would generally be easy to establish by considerations analogous to those that I applied in a few leading cases.

Significance of controversies.

This brief sketch is all that my objects allow me to give of the spiritual organism which was gradually wrought out through a course of ten centuries, by methods, various but united in aim, from St. Paul, who first conceived the general spirit of it, to Hildebrand, who systemized its social constitution; the intermediate period having been well occupied by the concurrence of all the noblest men of whom their race could then boast,—Augustine, Ambrosius, Jerome, Gregory, etc., etc.,—whose unanimous tendency to the establishment of a general unity, however impeded by the mediocrity of the common order of kings, was usually supported by sovereigns of high political ability,—such as Charlemagne and Alfred. From the spiritual organism we may now pass to the temporal; and having done with the political, we shall then be prepared for an analysis of the moral and mental character of the monotheistic *régime*.

Temporal organization of the *régime.*

Historical interpreters of the temporal condition of the Middle Ages are apt to assign a far too accidental character to it, by exaggerating the influence of the Germanic invasions. It would be easy to show, first, in answer to this, that the condition of society had so little of the fortuitous about it that it might have been actually anticipated (if the necessary knowledge had been obtainable) from the Roman system, modified by the Catholic; and that the feudal system would have arisen without any invasions: and, again, it may be shown that the invasions themselves were a necessary result of the final extension of the Roman dominion. After our late study of the progressive greatness of that dominion, and of its limitations, we easily perceive that the Roman empire must be bounded on one side by the great oriental theocracies, which were too remote and too incongenial for incorporation; and on another side, and especially westward, by nations, hunters, or shepherds, who, not being settled down, could not be effectually conquered: so that about the time of Trajan and the Antonines, the system had acquired all the extension it could bear, and might soon expect a reaction. As to the reaction,—it is evident that there can be no real conquest where the agricultural and sedentary mode of life does not exist among the vanquished, as well as the conquerors; for a nomade tribe, driven to seek refuge by removal, will be for ever passing to and fro between its refuge and its old haunts, and the return will be vigorous in proportion to the gradualism of the process of dislodging them from successive territories. In this way, the invasions were no more accidental than the conquests which provoked them; for the gradual driving back, by rendering the conditions of nomade existence more and more irksome, ended by greatly quickening the transition from nomade to agricultural life. The readiest method was to seize on the nearest favorable and prepared territory, whose owners, weakened in proportion to the extension of the empire, became more and more incapable of resistance. The process was as gradual as that of conquest, though we are apt to suppose otherwise from taking into the account none

The Germanic invasions.

but the successful final invasions: but the truth is, that invasion had begun, on a large scale, several centuries before Rome attained the summit of its greatness; though its success could not be of a permanent nature till the vigor of the empire, at its heart, began to be exhausted. So natural was this progressive result of the situation of the political world, that it occasioned large concessions, long before the fifth century; such as the incorporation of barbarians in the Roman armies, and the abandonment of certain provinces, on condition that new rivals should be kept in check. Pledged as I am to treat only of the advanced rank of humanity, it was yet necessary to say thus much of the reacting power, because from it mainly the military activity of the Middle Ages took its rise.

Rise of Defensive system.

Though the military system was carried on through the Middle Ages, it then essentially changed its character, as the civilized world found itself in a new position. Military activity lost its offensive character, and assumed that defensive office which all judicious historians point out as the characteristic quality of the feudal system. This change, powerfully facilitated by Catholicism, was, however, a necessary result of antecedent circumstances, like Catholicism itself. When the Roman extension was complete, it became a primary care to preserve its dominions; and the increasing pressure of the nations which had resisted conquest made such defence continually more urgent in importance.

Of territorial independence.

The military *régime* must thenceforward undergo that transformation into what is called the feudal system, by making political dispersion prevail over a concentration which was becoming continually more difficult as its aim was disappearing: for the dispersion agreed with a system of defence which required the direct and special participation of individuals; whereas, conquest had supposed the thorough subordination of all partial movements to the directing authority. Then was the time when the military chief, always holding himself in readiness for a territorial defence which yet did not require perpetual activity, found himself in possession of independent power in a portion of territory which he was able to protect, with the aid of his military followers, whom it was his daily business to govern, unless his power enabled him to reward them with inferior concessions of the same kind, which, again, might in time become susceptible of further division, according to the spirit of the system. Thus, without any Germanic invasion, there was, in the Roman system, a tendency to dismemberment through the disposition of the governors in general to preserve their territorial office, and to secure for it that hereditary succession which was the natural prolongation and the most certain pledge of their independence. The tendency was evident even in the East, which was comparatively untouched by invasion. The memorable concentration wrought by Charlemagne was the natural, though temporary result of the general prevalence of feudal methods, achieving the political separation of the West from the empire, which was thenceforth remanded to the East, and preparing for the future propagation of the fuedal system, without being able to restrain the dispersive tendency which constituted its spirit. The one remaining attribute of the feudal condition, that which relates to the modification of the lot of slaves, was another result of the change in the military system, which could not but occasion the transmutation of the ancient slavery into serfage, which was consolidated and perfected by the influence of Catholicism, as we shall presently see. As the importation of slaves declined with the decline of conquest, and finally came to an end, the internal traffic in slaves relaxed—their owners being disposed to make an hereditary property of them in proportion to the difficulty of obtaining new supplies. When slaves became thus attached to families and their lands, they became, in fact, serfs. Thus, whichever way we look at it, it appears that the feudal system would have arisen without any aid from barbaric invasion, which could do no more than accelerate its establishment; and thus we get rid of that appearance of fortuity which has disguised, even to the most sagacious minds, the true character of this great social change.

Slavery become serfage.

Before I proceed to consider the temporal characteristics of the feudal system, I must just point out the effect of the spiritual institution in preparing for it, and moderating the difficulties of the transition. From its station at the most general point of view, the Catholic authority saw the impending certainty of the Germanic invasions, and had nobly prepared to soften the shock by means of courageous missions to the expected invaders: and when they came, the northern nations found awaiting them a powerful clergy ready to restrain their violence toward those whom they vanquished, and from among whom the ranks of that clergy had been recruited. The moral energy and the intellectual rectitude of the conquerors were more favorable to the action of the Church than the sophistical spirit and corrupt manners of the enervated Romans; while, on the other hand, their comparative remoteness from the monotheistic state of mind, and their contempt for the conquered race, were difficulties in the way of the civilizing influence of Catholicism. It was the functions of the spiritual body to fuse the respective favorable qualities of the conflicting races, and to aid their subsidence into the system which was to ensue.

Intervention of the church.

The influence of Catholicism on each of the three phases under which the great temporal change to the feudal system presents itself is evident enough. It aided the transformation of offensive into defensive war by its own predominant desire to unite all Christian nations into one great political family, guided by the Church. By its intervention, it obviated many wars—actuated, no doubt, by a desire to prevent all diminution of its authority over the military chiefs, as well as by the principles and spirit proper to itself. All great expeditions common to the Catholic nations were, in fact, of a defensive character, and destined to put an end to successive invasions which might become habitual: such, for instance, as the wars of Charlemagne against the Saxons and the Saracens, and, at a later time, the Crusades, which were intended as a barrier against the invasion of Mohammedanism. Again: Catholicism aided the breaking up of the temporal power into small territorial sovereignties, favoring the transmutation of life-interests into hereditary fiefs, and organizing the relation of the principles of obedience and protection, as the basis of the new social discipline. Excluding the hereditary principle in its own structure, it countenanced it here, not under the form of custom or caste, but from a deep sense, however indistinct, of the true social needs of the age. Capacity was the title to power in the Church. On the land, capacity was best secured by that permanent attachment to the soil and to local traditions which secured stability at the same time, and involved the admission of the hereditary principle.

The training of the local ruler must be in his home, where he could be specially prepared for his future office, form his ideas and manners, and become interested in the welfare of his vassals and serfs; and all this could not be done without the hereditary principle, the great advantage of which consists in the moral preparation of the individual for his social function. In regulating the reciprocal obligations of the feudal tenure, the beneficent influence of Catholicism is unquestionable. It wrought by that admirable combination, unknown to antiquity, of the instinct of independence and the sentiment of devotedness which established the social superiority of the Middle Ages, when it exhibited a new spectacle of the dignity of human nature among privileged families who were few at first, but who served as a type to all classes, as they successively emerged into freedom. Again: Catholicism influenced the transmutation of slavery into serfage. The tendency of monotheism to modify slavery is visible even in Mohammedanism, notwithstanding the confusion between the temporal and the spiritual power which it still involves. It is therefore eminently conspicuous in the Catholic system, which interposes a salutary spiritual authority between the master and his slave, or the lord and his serf; an authority which is equally respected by both, and which is continually disposed to keep them up to their mutual duty. Traces of this influence may be observed even now, through a comparison of negro slavery in Protestant and Catholic America; the superiority of the lot of the negro in the latter case being a matter of constant remark by impartial investigators, though unhappily the Romish clergy are not clear of participation in this great modern error, so repugnant to its whole doctrine and constitution. From the earliest days, the Catholic power has tended, everywhere and always, to the abolition of slavery, which, when the system of conquest had closed, was no longer a necessary condition of political existence, and became a mere hinderance to social development; and not the less because this tendency has been disguised and almost annulled, on occasion, through certain obstacles peculiar to a few Catholic nations.

Institution of Chivalry.

These three characteristics of the temporal organization of the Middle Ages seemed to be summed up in the institution of Chivalry. Whatever were the abuses attendant upon it, it is impossible to deny its eminent social utility during an interval when the central power was as yet inadequate to the direct regulation of internal order in so new a state of society. Though Mohammedanism had, even before the Crusades, originated something like the noble associations by which Chivalry affords a natural corrective of insufficient individual protection, it is certain that their free rise is attributable to the Middle Age spirit; and we discern in it the wisdom of Catholicism converting a mere means of military education into a powerful social instrumentality. The superiority of merit to birth, and even to the highest authority, which was a principle of these affiliations, is quite in the Catholic spirit. We must however bear in mind the dangers involved in this institution, and especially the peril to the fundamental principle of the *régime* when the exigencies of the Crusades created those exceptional orders of European chivalry which united the monastic to the military character, for the purposes of their enterprise. As a natural consequence, this union of qualities bred a monstrous ambition, which dreamed of that very concentration of spiritual and temporal power that the spirit of the age had been occupied in dissolving. The Templars, for instance, were instinctively formed into a kind of conspiracy against royalty and the papacy at once; and kings and popes had to lay aside their disputes and unite for the destruction of their common foe. This was, it seems to me, the only serious political danger that social order had to encounter in the Middle Ages. That social order was, in fact, so remarkably correspondent with the contemporary civilization, that it sustained itself by its own weight as long as the correspondence lasted.

Operation of the Feudal system.

Here, then, we see the feudal system to be, in a temporal sense, the cradle of modern society. It set society forward toward the great aim of the whole European polity—the gradual transformation of the military into the industrial life. Military activity was then employed as a barrier to the spirit of invasion, which, if not so checked, would have stopped the social progress; and the result was obtained when, at length, the peoples of the North and East were compelled by their inability to find settlements elsewhere, to undergo at home their final transition to agricultural and stationary life, morally guaranteed by their conversion to Catholicism. Thus the progression which the Roman system had started was carried on by the feudal system. The Roman assimilated civilized nations; and the feudal consolidated that union by urging barbarous peoples to civilize themselves also. The feudal system, regarded as a whole, took up war at its defensive stage, and, having sufficiently developed it, left it to perish, for want of material and object. Within national limits its influence had the same tendency, both by restricting military activity to a diminishing caste, whose protective authority became compatible with the industrial progress of the nascent working class, and by modifying the warlike character of the chiefs themselves, which gradually changed from that of defender to that of proprietor of territory, in preparation for becoming by-and-by the mere dictator of vast agricultural enterprise, unless indeed it should degenerate into that of Courtier. The great universal tendency, in short, of the economy was to the final abolition of slavery and serfage, and afterward, the civil emancipation of the industrial class, when the time of fitness should arrive.

From the political, I next proceed to the moral aspect of the monotheistic *régime*.

Morality under Catholicism.

As the social establishment of universal morality was the chief destination of Catholicism, some may wonder that I did not take up my present topic at the close of my account of the Catholic organization, without waiting till I had exhibited the temporal order. But I think I am placing the subject in the truest historical light by showing that it belongs to the whole system of political organization proper to the Middle Ages, and not to one of its elements alone. If Catholicism first secured to morality the social ascendency which is its due, feudalism, as a result of the new social situation, introduced precious germs of a lofty morality peculiar to itself, which Catholicism expanded and improved, but without which it could have had no complete success. Both issuing from antecedent circumstances, Catholicism was the active and rational organ of a progression naturally occasioned by the new phase which human development had assumed. The military and national morality of antiquity, subordinate to polity, had given place to a more pacific and universal morality, predominant over polity, in proportion as the system of conquest became changed into one of defence. Now the social glory of Catholicism, —a glory which mankind will gratefully commemorate when all theological faiths shall have become matters of mere historical remembrance,—is that it developed and regulated to the utmost a tendency which it could not have created. It would be to exaggerate most mischievously the influence, unhappily only too feeble, of any doctrines on human life, to attribute to them the power of so changing the essential mode of human existence. If Catholicism had been transplanted untimely among nations which had not achieved the preparatory progress, its social influence would not have been sustained by the moral efficacy which distinguished it in the Middle Ages. Mohammedanism is an illustration of this. Its morality, derived from Christianity, and no less pure, is far from having produced the same results, because its subjects were insufficiently prepared for a monotheism which was, in their case, far from spontaneous, and altogether premature. We must not then judge of Middle Age morality from the spiritual point of view, without the temporal; and we must moreover avoid any attempt to give prece-

Rise of morality over polity.

dence to either element, each being indispensable, and the two therefore inseparable.

A great error of the metaphysical school is that of attributing the moral efficacy of Catholicism to its doctrine alone, apart from its organization, which is indeed supposed to have an opposite tendency. It is enough, in answer to this, to refer to what I have already said of the action of the Catholic organization, and to the moral inefficacy of Mohammedanism, and of Greek or Byzantine Catholicism, which, with abundance of doctrinal power, have socially failed for want of a spiritual organization. Like them, Catholicism would have produced its morality in feeble formulas and superstitious practices, suitable to the vague and unconnected character of theological doctrine, if it had not provided for the constant active intervention of an independent and organized spiritual power, which constituted the social value of the religious system. In order to estimate what this operation was, I will briefly consider first how the doctrines of Catholicism wrought in a moral view, apart from their corresponding organization.

Source of moral influence.

The most important question, in this connection, is whether the moral influence of Catholicism in the Middle Ages was owing to its doctrines being the organs for the constitution of certain common opinions, which, when once established, must have permanent moral power from their universality; or whether, according to the popular view, the results are ascribable to personal hope, and yet more, fear, with regard to a future life, which Catholicism applied itself to co-ordinate and fortify more completely than any other religion has ever attempted to do, precisely by avoiding all dogma on the subject, and leaving every one's imagination to create there wards and punishments which would be most effectual in his case. The question can, it is obvious, be decided only by observation of exceptional cases, in which general opinion and religious precepts are in opposition; for, when they co-operate, it is impossible to know how much influence to assign to the one or the other. Rare as are these exceptional cases, there are enough in every age of Catholicism to satisfy us in regard to the great axiom of social statics,—that public prejudices are habitually more active than religious precepts, when any antagonism arises between these two moral forces, which are usually found convergent. The instance adduced by Condorcet—that of the duel—appears to me sufficiently decisive. This custom, imposed by military morals, induced pious knights to brave the strongest religious condemnation in the most brilliant ages of the Church; whereas, at this day, we see the duel spontaneously disappearing by degrees under the strengthening sway of industrial morals, notwithstanding the entire practical decay of religious prohibition. This one instance will guide the reader in his search for analogous cases, all of which will be found more or less illustrative of the tendency in human nature to brave a remote danger, however fearful, rather than immediate discredit in a fixed and unanimous public opinion. It seems, at first sight, as if nothing could counterbalance the power of religious terror directed upon an eternal future: but it is certain that, by the very element of eternity, the threat loses its force; and there have always been strong minds which have inured themselves to it by familiarity, so as not to be trammelled by it in the indulgence of their natural impulses. Every continued sensation becomes, by our nature, converted into indifference; and when Milton introduces alternation in the punishment of the damned, doomed "from beds of burning fire to starve in ice," the idea of the Russian bath raises a smile, and reminds us that the power of habit extends to alternation, however abrupt, if it be but sufficiently repeated. The same energy which urges to grave crimes fortifies minds against such a future doom, which may also be considered very uncertain, and is always becoming familiarized by lapse of time; and, in the case of ordinary people, while there was absolution in the distance, as there always was, it was easier to violate religious precepts to the moderate extent their character of mind required, than to confront public prejudice. Without going further into this kind of analysis, we are warranted in saying that the moral power of Catholicism was due to its suitability as an organ of general opinions, which must become the more powerfully universal from their active reproduction by an independent and venerated clergy; and that personal interest in a future life has had, comparatively, very little influence at any time upon practical conduct.

The moral regeneration wrought by Catholicism was begun by the elevation of Morals to that social supremacy before accorded to polity. This was done by subordinating private and variable to the most general and permanent needs, through the consideration of the elementary conditions of human nature common to all social states and individual conditions. It was these great necessities which determined the special mission of the spiritual power, whose function it was to express them in a form of universal doctrine, and to invest them with sanctity in real life, individual and social; a function which supposed an entire independence of the temporal power. No doubt, this beneficent social action was much impaired by its connection with the theological philosophy,—by the vagueness with which that philosophy infected its moral prescriptions,—by the too arbitrary moral authority possessed by the directing body, whose absolute precepts would otherwise have been impracticable,—and again, by the inherent contradiction of a doctrine which proposed to cultivate the social affections by the prior encouragement of an exorbitant selfishness, forever occupied with its own future lot, looking for infinite reward for the smallest well-doing, and thus neutralizing the sympathetic element which resides in the benign universal affection of the love of God; yet these great and inevitable evils have not prevented, but only impaired, a regeneration which could not have begun in any other way, though it must be carried on and perfected on a better intellectual basis in time to come.

Thus was Morality finally placed at the head of social necessities, by conceiving of all the faculties of our nature as means subordinate to the great end of human life, directly sanctioned by a universal doctrine, properly erected into a type of all action, individual and social. It must be acknowledged that there was something thoroughly hostile to human development in the way in which Christianity conceived of the social supremacy of morality,—greatly as this opposition has been exaggerated: but Catholicism, at its best period, restrained this tendency, inasmuch as it recognised capacity as the basis of its ecclesiastical constitution: but the elementary disposition, whose philosophical danger became apparent only when the Catholic system was in its decline, did not interfere with the radical justness of the social decision which subordinated mind itself to morality. Superior minds, which multiplied in number by means of spreading cultivation, have always, and especially of late, secretly rebelled against a decision which restrained their unlimited ambition; but it will be eternally confirmed, with deep-felt gratitude, amidst all disturbances, both by the multitude to whose welfare it is directed, and by philosophical insight, which can fitly analyze its immutable necessity. Though mental superiority is the rarest and most valuable of all, it can never realize its highest expansion unless it is subordinated to a lofty morality, on account of the natural feebleness of the spiritual faculties in human nature. Without this condition the best developed genius must degenerate into a secondary instrument of narrow personal satisfaction, instead of pursuing that large social destination which can alone offer it a field and sustenance worthy of its nature. Hence, if it is philosophical, it will strive to systemize society in accordance with its own inclinations: if scientific, it will be satisfied with superficial conceptions, such as will procure an easy and profitable success: if æsthetic, it will produce unprincipled works, aspiring, at almost any cost, to a rapid and ephemeral popularity: and if industrial, it will not aim at capital inventions, but at lucrative modifications. These melancholy results of mind deprived of moral direction, which can not annul the value of social genius, though largely neutralizing it, must be most vicious among men of second-rate ability, who have a weaker spontaneousness; and then intelligence, which is valuable only in improving the prevision, the appreciation, and the satisfaction of the chief real needs of the individual and of society issues in an unsocial vanity, or in absurd pretensions to rule society in virtue of capacity, which released from the moral condition of the general welfare, become equally injurious to private and public happiness. In the view of all who have studied human nature, universal love, as proposed by Catholicism, is of more importance than intellectual good itself, because love makes the most of even the humblest mental faculties, for the benefit of each and all; whereas, selfishness perverts or paralyzes the most eminent powers, which then become more disturbing than beneficial to both public and private welfare. Such is the evidence of the profound wisdom of Catholicism in placing morality at the head of human interests, as the guide and controller of all human action. It thus certainly established the main principle of social life: a principle which, however occasionally discredited or obscured by dangerous sophisms, will ever arise with increasing clearness and power from a deepening study of the true nature of Man.

Moral Types.

In all moral appreciation of Catholicism, we must bear in mind that, in consequence of the separation between the spiritual and the temporal power, and therefore of the independence of morality in regard to polity, the moral doctrine must be composed of a series of types, which, not expressing immediate practical reality, fix the ideal limit to which our conduct must approximate more and more. These moral types are, in nature and object, analogous to the scientific and æsthetic types which guide our various conceptions, and which are needed in the simplest human operations, even the industrial. It would be as wise to reproach the artist for the unattainable perfection of his ideal model, as Catholic morality for the supposed exaggeration of its requirements. In both cases the attainment will fall short of the ideal; but it will be greater than it could be without the ideal. The philosophical instinct of Catholicism led it to fulfil the practical conditions of the case by transferring the type from the abstract to the concrete state. It applied its social genius in gradually concentrating in the Founder of their system all the perfection that they could imagine in human nature, thus constituting a universal and operative type, admirably adapted to the moral guidance of humanity, and in which the highest and the humblest could alike find a model for human conduct; and they completed the lesson by the addition of that yet more ideal conception which offers as the feminine type the beautiful mystic reconciliation of purity with maternity.

There is no department of general morality which was not eminently improved by Catholicism, as I could show, if my space and my purpose admitted of it. I can only briefly point out the most important instances of advancement, under the three heads of personal, domestic, and social morality.

Personal morality.

The great aim being the exaltation of reason over passion, Catholicism, justly regarded personal virtues as the basis of all others. The sanitary practices and the personal privations it imposed had therefore some social efficacy, being, at the least, beneficial auxiliaries to moral education,—especially in the Middle Ages. Again, the personal virtues which were recommended in more ancient times as a matter of individual prudence were now first conceived of in a social connection. Humility, so strongly enforced by Catholicism as to form a popular reproach against it, was of eminent importance, not only during a period of haughty oppression which proved its necessity, but in reference to the permanent moral wants of human nature, in which we need not fear that pride and vanity will ever be too much repressed Nothing is more remarkable, under this head, than the reprobation of suicide, which had been erected into a sort of honor among the ancients, who valued their own lives no more than other people's; or, at least, into a resource which their philosophers were not blamed for recurring to. This anti-social practice would no doubt have declined with the predominance of military manners, but it is certainly one of the moral glories of Catholicism to have organized an energetic condemnation of it.

Domestic morality.

Under Catholicism, domestic morality issued forth from the subjection to polity in which the ancients had placed it, and assumed its proper rank. When the spiritual and temporal orders were separated, it was felt that the domestic life must henceforth be the most important for the mass of mankind,—political life being reserved for the exceptional few, instead of absorbing everything else, as it did when the question concerned the minority of free men in a population of slaves. The special care of Catholicism for domestic life induced such a multitude of happy results as defies even the most summary analysis here. The reader must imagine for himself the improvement in human families when Catholic influence penetrated every relation, to develop without tyranny the sense of reciprocal duty,—solemnly sanctioning, for instance, the paternal authority, while abolishing the ancient patriarchal despotism, under which infants were murdered or abandoned, —as they still were, beyond the pale of monotheism. I can specially notice only what relates to the closest tie of all, with regard to which I am of opinion that we have only to consolidate and complete what Catholicism has happily organized. No one now denies that it essentially improved the social condition of women; but it is seldom or never remarked that it deprived them of all participation whatever in sacerdotal functions, even in the constitution of the monastic orders to which they were admitted. I may add that it also, as far as possible, precluded them from royalty in all countries in which it had political influence enough to modify, by the consideration of aptitude, the theocratic principle of hereditary succession, embodied in caste. The benefit bestowed on women by Catholicism consisted in rendering their lives essentially domestic, in securing the due liberty of their interior existence, and in establishing their position by sanctifying the indissolubleness of marriage; whereas, even among the Romans, who married but one wife, the condition of women was seriously injured by the power of divorce. I shall have occasion hereafter to treat of the evils attending the power of divorce. In the intermediate period of human history, when Catholicism interdicted it, that beneficent influence so connected the two sexes that, under the morals and manners of the system, the wife acquired an imprescriptible right, independent even of her own conduct, to an unconditional participation in not only all the social advantages of him who had once chosen her, but, as far as possible, in the consideration he enjoyed; and it would be difficult to imagine any practicable arrangements more favorable to the dependent sex. As civilization develops the essential differences of the sexes, among others, it has excluded women more and more from all functions that can withdraw them from their domestic vocation. It is in the higher classes of society that women work out their destination with the least hinderance; and it is there, in consequence, that we may look for a kind of spontaneous type, toward which the condition of women must, on the whole, tend; and looking there, we apprehend at once the law of social progression, as regards the sexes, which consists in disengaging women more and more from all employment that is foreign to their domestic functions; so that, for instance, we shall hereafter reject, as disgraceful to Man, in all ranks, as now in the higher, the practice of subjecting women to laborious occupations; whereas they should be universally, and more and more exclusively, set apart for their characteristic offices of wife and mother.

Social morality.

In regard to social morality, properly so called, every one will admit the distinctive influence of Catholicism in modifying the energetic but savage patriotism of the ancients by the higher sentiment of humanity or universal brotherhood, so happily popularized by it under the sweet name of charity. No doubt the nature of the Christian doctrines, and the religious antipathies which resulted from them, greatly restricted this hypothetical universality of affection, which was generally limited to Christian peoples; but within these limits the brotherly affections of different nations were powerfully developed, apart from the common faith which was its principle, by their uniform habitual subordination to one spiritual authority, whose members were, notwithstanding their separate nationalities, fellow-citizens of Christendom. It is a true remark that the improvement of European relations, the advancement of international law, and the humane conditions imposed, more and more, on war itself, may all be referred to the period when Catholic influence brought all parts of Europe into connection. In the interior condition of each nation to duties which arise out of the great Catholic principle of universal brotherhood, and which have temporarily failed only through the decay of the theological system which imposed them, afforded the best obtainable means to remedy the inconveniences inseparable from the social state; and especially the imperfect distribution of wealth. This was the source of so many admirable foundations devoted to the solace of human suffering, institutions unknown in ancient times, and the more remarkable because they usually grew out of private munificence, in which public co-operation has seldom any part.—While expanding the universal sentiment of social union, Catholicism did not neglect that of perpetuity, which is, as I have before pointed out, its natural complement, connecting all times as well as all places. This was the general use of the great system of customary commemoration, so happily constructed by Catholicism, in wise imitation of polytheism. If I had space, it would be easy to show how wise were the precautions introduced by Catholicism and usually respected, to make canonization, replacing deification, fulfil its social purpose by avoiding the disgraceful abuses caused by the confusion of the spiritual and temporal powers among the Greeks, and yet more the Romans, in their declining period: so that the lofty recompense was very rarely decreed to men who were not more or less eminently worthy, remarkable, or useful, while they were selected, with careful impartiality, from every class of society, from the highest to the lowest.

We may now form some idea of the vastness of the moral regeneration accomplished by Catholicism in the Middle Ages. Impaired as it was by the imperfections of the philosophy, and the difficulties of the social phase of the time, it manifested the true nature of the requisite improvement, the spirit which must guide it, and the attendant conditions, in preparation for the time when a sounder philosophy should permit the completion of the work. It remains for us to review the intellectual attributes of the system. It may appear that the supreme importance of the social mission of Catholicism could not but restrict the development of its intellectual characteristics: but the consequences of those attributes make up our present experience; and all that has happened in human history, from the Catholic period till now, is an unbroken chain of connection which links our own period with that cradle of modern civilization. We shall see that the entire spiritual movement of modern times is referrible to that memorable season in human history, which Protestantism is pleased to call the dark ages.

Intellectual condition under Catholicism.

Our theory explains how the intellectual movement of the monotheistic system might be retarded without its following that the system was hostile to human progression. It never was so except during its decline (and then much less than is commonly supposed), when it was engrossed with the cares of self-preservation. It is an exaggeration also to attribute to the Germanic invasions the retardation of intellectual development during the Middle Ages; for the decline was taking place for centuries before the invasions were of any engrossing importance. Two facts, one of time and one of place, may throw light upon this ill-understood question. The supposed revival of human intelligence (which however had not been asleep, but only otherwise employed), in other words, the acceleration of the mental movement, immediately followed upon the full maturity of the Catholic system, in the eleventh century, and took place during its high social ascendency. Again, it was in the very centre of this dominion, and almost before the eyes of the supreme sacerdotal authority, that the acceleration appeared; for it is impossible to deny the superiority of Italy in the Middle Ages, under all the four aspects of intellectual action. These two facts are enough to show how favorable Catholicism then was to human development. The preceding inactivity was owing to the laborious and anxious character of the task of organizing the system; a work of supreme importance, absorbing almost the whole intellectual resources, and commanding the strongest interest of the peoples concerned: so that the provisional direction of the mental movement was left to second-rate minds, amidst a state of affairs which was unfavorable to marked progression, and which barely allowed the preservation of what had been gained. This seems to me the simple and rational explanation of this apparent anomaly: and it releases us from the necessity of imputing to any men, institutions, or events, any tendency to repress the human mind, while it refers us to the great obligation to devote the highest abilities to the task required, in each age, by the chief needs of mankind: and certainly nothing could, in this view, be more interesting to all thinkers than the progressive development of Catholic institutions. The intellectual movement, which had never stopped, was joined, in the time of Hildebrand, by all the intellect that was set free by the completion of the Catholic system, and of its application to political life; and then were realized the vast consequences which we shall have to review in a subsequent chapter. The share attributed to the Arabs in the revival is much exaggerated, though they may have assisted a movement which would have taken place, somewhat more slowly, without them: and their intervention had nothing accidental about it. Mohammed attempted to organize monotheism among a people who were in every way unprepared for it: the effort issued in a monstrous political concentration, in the form of a military theocracy; yet the intellectual qualities inherent in monotheism could not be wholly annulled; and they even expanded with the more rapidity from the failure of the corresponding *régime*, whereby the highest spiritual capacities were left free for intellectual pursuits; and especially for those which had been remanded to the East, while the West was occupied with the development of the Catholic system. Thus the Arabs make their appearance in the midst of the western interregnum, without their intervention being at all necessary in the transition from the Greek to the modern evolution, The special reasons for the intellectual properties of the monotheistic system being developed only in the age of its decline, will be best considered when I treat of that decline. Having assigned the general grounds of the delay, I have to notice briefly the four aspects in which the mental influence of Catholicism presents itself.

Philosophy.

The aptitude of Catholicism for philosophy is as remarkable as it is ill-appreciated. However imperfect we now know the theological philosophy to be, it exercised a happy influence over the intellectual development of the multitude, among whom, as we have seen, it is the glory of the system to have spread its educational benefits. They were lifted above the narrow circle of their material life; their habitual feelings were purified; and sound, though empirical notions of the moral nature of Man, and even some dawn of historical conception, through the connection of general history with the Church, were conveyed to the

Science.

whole range of classes of society. Through the efforts of Catholicism to prove its superiority to former systems, even the great philosophical principle of human progression began to arise throughout Christendom,—however inadequate in strength or quality. When each individual thus became empowered to judge of human actions, personal and collective, by a fundamental doctrine, the spirit of social discussion which distinguishes modern periods began to arise. It could not exist among subordinate persons while the two authorities were concentrated in the same holders: and, when the separation was effected, the spirit of discussion was long restrained by the intellectual discipline imposed by the vague and arbitrary nature of the theological philosophy: but it was at this time that it began to move.—As for the cultivated class, the leading fact on their behalf was that Catholicism generally allowed free scope to the metaphysical philosophy, to which the polytheistic *régime* was hostile. It was under Catholicism that the metaphysical philosophy was extended to moral and social questions; and, in proof of the protecting disposition of the *régime*, we have the fact that the calumniated Middle Ages gave the first worthy reception to the most advanced part of Greek philosophy,—that is, to the doctrine of Aristotle, which had certainly never been so appreciated before,—even by the Greeks themselves. We must point to the separation of the spiritual and temporal powers as an intellectual as well as social service, because it separated at the same time social theory from practice, and thus laid the foundation of social science, in distinction from mere Utopias. Earnestly as I have insisted that social science is only now beginning to be formed, I acknowledge with gratitude that its source lies in that remote age, called dark: where it is seldom sought for by those who make the freest use of its benefits. The scientific influence of Catholicism was equally favorable. Monotheism is not, it is true, very consistent with the conception of the invariableness of natural laws; and there is a stage of human development at which the monotheistic doctrine, with its conception of an arbitrary will as the universal governing power, is the only essential obstacle to the view which lies at the base of science. But that stage was not in the Middle Age period; and monotheism was of immense service in disengaging the scientific spirit from the trammels imposed by polytheism. Before, a few simple mathematical speculations were all that was possible, when all scientific inquiry must clash with the theological explanations which extended to the minutest details of all phenomena. When monotheism concentrated the supernatural action, it opened a much freer access to these secondary studies, and did not interpose any sacred doctrine as an obstacle, as long as some vague and general formulas were respected; and at that time, the religious disposition to admiration of divine wisdom, which has since proved a retrograde influence, was promotive of scientific inquiry. I need not point out that, as polytheism was a state of religious decline, in comparison with fetichism, so was monotheism in regard to polytheism. The suppression of inspiration, with all its train of oracles and prophecies, apparitions and miracles, testifies to the noble efforts of Catholicism to enlarge, at the expense of the theological spirit, the as yet narrow field of human reason, as far as the philosophy of the period would allow. Adding to these considerations that of the facilities which sacerdotal life afforded to the intellectual culture, we may conceive of the happy influence of the monotheistic *régime* on the growth of the chief natural sciences:—in the creation of Chemistry, founded on Aristotle's conception of the four elements, and sustained by the wild hopes which were necessary to stimulate nascent experimentation:—in the improvement of Anatomy, so restricted in more ancient times:—and in the development of pre-existing mathematical speculation and astronomical knowledge; a progression which was attested by the rise of algebra, as a distinct branch of ancient arithmetic, and by that of trigonometry, which was, in the hands of the Greeks, too imperfect and limited for the growing requirements of Astronomy.

Art.

The æsthetic influence of monotheism did not reach its highest point till the next period; but it is impossible to be blind to its scope when we consider the progress made by music and architecture during the Middle Ages. The introduction of musical notation and the development of harmony gave a wholly new character to Song; and the same extension was given to instrumental music by the creation of its most powerful and complete organ; and the share borne by Catholic influence in each needs no pointing out. Its effect on the progress of Architecture is equally clear. It was not only that there was a great change in ordinary habitations, in consequence of the private relations, under Catholic and feudal encouragement, succeeded to the isolation of the domestic life of the ancients. Besides these improvements in private life, there arose those religious edifices which are the most perfect monumental expression of the ideas and feelings of our moral nature, and which will for ever, notwithstanding the decay of the corresponding beliefs, awaken in every true philosopher a delicious emotion of social sympathy. Polytheism, besides that its worship was outside the temples, could not originate an improvement which was appropriate to a system of universal instruction, followed up by a continuous habit of personal meditation. In regard to poetry, it is enough to name Dante to show what the system could effect, notwithstanding the obstacles presented by the slow and laborious elaboration of the modern languages, and the difficulty arising from the equivocal and unstable character of the corresponding social state, which was unfavorable to poetical inspiration. I noticed before the superior aptitude of polytheism in this respect even to this day, as is shown by the inability of even our best poets to free modern poetry from its traces. As to the rest, the influence of the period, in this case as in others, so stretches forward into the next, that we can not appreciate its services fully till we arrive at that part of our analysis.

Industry

Turning now to the lower and more universal aspect of the mental movement,—the industrial,—it is clear that, starting from the time of personal emancipation, we must adjourn the estimate of industrial progress to the next period. The greatest industrial improvement of all however must be the gradual abolition of serfage, accompanied by the progressive enfranchisement of communities such as was accomplished under the guardianship of the Catholic system, and furnished the basis of the vast success of a later time. We may notice here—what we must dwell longer on hereafter—the new character of industry, shown in the substitution of external forces for human efforts. It was not only that men were becoming better acquainted with nature: a stronger reason was that the Catholic and feudal world were placed in a wholly new position by the emancipation of laborers, whence arose the general obligation to spare human forces by using inorganic or brute assistance. As evidence of this, we may notice the invention of water-mills, wind-mills, and other machines, the origin of which we are too apt to overlook. It was the slavery more than the ignorance of a prior time that prevented the use of machinery, which could not be sufficiently desired while there was an abundant provision of intelligent muscular force always at hand; and when the use of machinery had begun, we trace the wisdom of the Catholic system in interposing between this inevitable improvement and the theological discouragement which must forbid any great industrial modification of the external world as a direct offence against the providential optimism which had succeeded to the polytheistic fatalism.

This brief survey seems to prove the injustice of the reproach of barbarism and darkness brought against the period; against the very age illustrated by Thomas Aquinas, Albertus Magnus, Roger Bacon, Dante, and others. To conclude our analysis of the period, I have only to exhibit the principle of the irrevocable decay of this transitory system, the great destination of which was to prepare for the gradual and safe decomposition of the theological and military *régime*, taking place at the same time with the rise and expansion of the new elements of order.

Provisional nature of the *régime.*

Whichever way we look at the organization proper to the Middle Ages, its provisional nature is evident from the fact that the developments it encouraged were the first causes of its decay. In the spiritual region the concentration of deity into one object was the last possible modification, as the reduction could go no further without a total perversion of the theological philosophy, and the loss of its social ascendency; while, at the same time, the more rapid and extensive rise of the positive spirit, not only among educated men, but among the masses of civilized nations, could not but bring on such fatal modifications. We have seen that the existence of the Catholic system depended on numerous conditions, the failure of any one of which involved the destruction of the whole; and we have ascertained the precariousness of the greater number of those conditions. The system was not, as I have shown, hostile to intellectual progress: on the contrary, it favored it; but it never incorporated that improvement with itself. The improvement grew up under the shelter of Catholicism; but it outgrew the provisional protection, which was thenceforth done with. The great intellectual office of Catholicism was to prepare, under the theological *régime*, the elements of the positive *régime*. In the same way, in morals it prepared men for the new system by encouraging the exercise of human reason in judging of conduct; and thus it rendered the downfall of theological influence inevitable—apart from the instruction it gave to Man's moral nature to revolt against its own violations of his noblest feelings in support of its declining existence—thus offending, in its hour of necessity, the moral sentiments which were its own best work.

Division between Natural and Moral Philosophy.

If we are to trace the principle of decay through its whole existence, we must admit that it was older than the system itself; for we find it in the great division, considered in a former chapter, between natural and moral philosophy; the philosophy of the inorganic world, and that of moral and social Man. This division, proposed by the Greek philosophers a little before the establishment of the Alexandrian Museum, by which it was openly sanctioned, was the first logical condition of all future progress, because it permitted the independent growth of inorganic philosophy (then in the metaphysical stage) whose more simple speculations might be rapidly perfected without injury to the social operation of moral philosophy (then in its theological stage), which was much less occupied with the abstract improvement of its doctrines, than with trying the fitness of theological conceptions for civilizing mankind. A rivalry, extending from doctrines to persons, immediately grew up between the metaphysical spirit, which was in possession of the scientific domain, and the theological, which governed morals: and it was the social ascendency of moral philosophy which kept down intellectual enterprise in the direction of natural philosophy, and was the first cause of the retardation of science which I explained just now. We see the conflict reflected in the struggles of such a man as St. Augustine against the mathematical reasonings, already popularized among students of natural philosophy, by which the Alexandrian philosophers proved the form of the earth, and the necessary existence of antipodes. One of the most illustrious founders of the Catholic philosophy was seen enforcing objections so puerile that the lowest understandings would not now condescend to them. Comparing this case with that before mentioned, of the astronomical extravagances of Epicurus, we shall see how thorough was this separation—very like antipathy—between natural and moral philosophy.

The Metaphysical spirit.

It was the metaphysical spirit which had wrought the transition from fetichism to polytheism; and, quite recently, from polytheism to monotheism; and it was not likely to desist from its office of modification at the moment when it was most earnest and strong. As there was nothing beyond monotheism but a total issue from the theological state, which was then impracticable, the metaphysical action became destructive, and more and more so; its propagators being unconsciously employed in spoiling, by their antisocial analyses, the very conditions of existence of the monotheistic system. The more Catholicism aided the intellectual movement, the faster did the destruction proceed, because every scientific and other intellectual advance added honor to the metaphysical spirit which appeared to direct it. The antagonism was certain to overtake Catholicism when it had fulfilled the social conditions which were its proper office, and when intellectual conditions should become the most important to human development. Thus the general cause of the mental dissolution of Catholicism was its inability to incorporate with itself the intellectual movement, by which it was necessarily left behind; and, from that time, the only way in which it could maintain its empire was by exchanging its progressive for a stationary, or even retrograde character, such as sadly distinguishes it at this day. It may be thought, in a superficial way, that the intellectual decline may be reconciled with an indefinite protraction of that moral sway to which Catholicism seems to be entitled by the excellence of its own morality, which will be respected when the prejudices of its enemies have died out: but it is philosophically true that moral influence is inseparable from intellectual superiority; for it can never be in the natural course of things for men to give their chief confidence, in the dearest interests of their life, to minds which they respect so little as not to consult them about the simplest speculative questions. Catholicism was once the organ of universal morality; and we now accept it as a precious legacy, without insisting that the giver shall not die, or refusing the gift because the bestower is dead. We have derived valuable truth from astrology and alchemy, finding the truth remain when the vehicle was broken up: and the process is the same in the case of the moral and political progress set on foot by the theological philosophy. It could not perish with the philosophy, if another spiritual organization had been meantime prepared to receive it—as we shall see hereafter.

Temporal decline.

The temporal decline of the Middle Age system proceeded from a cause so evident as to require little remark. In all the three aspects of the feudal *régime*, its transitory character is distinctly marked. Its defensive organization was required only till the invaders should have settled down into agricultural life at home, and become converted to Catholicism: and military pursuits thenceforth became more and more exceptional, as industry strengthened and extended itself. The breaking up of the temporal power into partial sovereignties, which was the second feature of the feudal system, was no less a transient arrangement, which must give place to a new centralization; as we shall presently see that it did. As for the third feature—the transformation of slavery into serfage—it is unquestionable that while slavery may exist a long time under suitable conditions, serfage can be no more than a transition state, sure to be speedily modified by the establishment of industrial communities, and serving no other special purpose than gradually leading on the laborers to entire personal freedom. Thus, it is the same with feudalism as with Catholicism—the better it discharged its functions, the more it accelerated its own destruction. External circumstances, however, which were in themselves in no degree accidental, prolonged the duration of the system very unequally among the European nations—its political rule having lasted longest on the various frontiers of Catholic feudal civilization, that is, in Poland, Hungary, etc., with regard to Tartar and Scandinavian invasions; and even, in some respects, in Spain and the larger Mediterranean islands, especially Sicily, with regard to Arab encroachments: a distinction which it is well to notice here in its germ, as we shall find an interesting application of it in a future part of our analysis. This short explanation will help us to fix on the class by whom the disintegration of the feudal system was conducted. The advent of the industrial class was the issue from it; but it could not be that class which should conduct the process, on account of its subordinate position, and of its having enough to do in its own interior development. The work was done by the legists, who had risen in social influence as military activity declined. Like the metaphysicians, they had a provisional office; and the one class in philosophy, and the other in polity, effected the critical modifications required, and founded nothing.

Conclusion.

The reflection which naturally occurs at the end of our survey of the monotheistic *régime* is that the immense time required for its slow political elaboration is out of all proportion to the short period of its social sway: its rise having occupied ten centuries; whereas it remained at the head of the European system for only two—from Gregory VII., who completed it, to Boniface VIII., under whom its decline conspicuously commenced—the five following centuries having exhibited only a kind of chronic agony perpetually relaxing in activity. The only possible solution of this great historical problem is that the part of Catholicism which was thus destined to expire was the doctrine, and not its organization, which was only transiently spoiled through its adherence to the theological philosophy; while, reconstructed upon a sounder and broader intellectual basis, the same constitution must superintend the spiritual reorganization of modern society, except for such differences as must be occasioned by diversity of doctrine. We must either assent to this, or suppose (what seems to contradict the laws of our nature) that the vast efforts of so many great men, seconded by the persevering earnestness of civilized nations, in the secular establishment of this masterpiece of human wisdom, must be irrevocably lost to the most advanced portion of humanity, except in its provisional results. This general explanation is grounded on the considerations we have just reviewed, and it will be confirmed by all the rest of our analysis, of which it will be the main political conclusion.

CHAPTER X.

METAPHYSICAL STATE, AND CRITICAL PERIOD OF MODERN SOCIETY.

Conduct of the inquiry.

We have seen the theological philosophy and the military polity supreme in antiquity: we have seen them modified and enfeebled in the Middle Ages: and we have now to study their final decline and dissolution in the transitional modern period, in preparation for a new and permanent organic state of society. The task seems to mark out its own division. I must first review the process of the dissolution of the old systems; and this will be the work of the present chapter: and next, I shall exhibit the progressive evolution of the chief elements of the positive system. The two processes are inseparably connected in practice, as we must carefully remember: but they must be divided in analysis, or the conjunction of two orders of considerations so opposite as decomposition and recomposition would introduce endless confusion into our speculations. Such a division was not necessary in treating of earlier periods, because such opposing movements as then existed were convergent; and such transitions as took place were from one phase of the theological system to another. But the case is different when we have to study the issue from the theological system into one which is of a wholly different nature—that is, the greatest revolution, intellectual and social, that the human race could undergo at any period of its career. We should even lose sight of the organic elements of the case in their critical investiture, if we did not study them by themselves, and after the others. In a concrete history, of course, this process would be out of the question: but the form of our historical review has been abstract throughout; and, this being the case, we are not only permitted but bound to use such a method as may best illustrate our subject. Such a method is the division I propose. What we have to be careful of is to bear in mind that the two processes, though separated here for purposes of investigation, are for ever co-operating;—the destruction of old elements being the very means of disclosing the new; the motive force of one period naturally imparting itself to the next; and the mutual reaction of the antagonistic systems being favorable to the functions of both. One side of this view is evident enough: we all see how the disorganization of the theological and military system aided the scientific and industrial development of a later time: but the reverse action is less understood, though it is not less important. We shall see as we proceed, however, that it was the latent development of the positive spirit which sustained and substantiated the gradual ascendency of the metaphysical spirit over the theological—saving it from utter waste in bootless discussion, and directing it toward a genuine philosophical renovation. The same office is fulfilled by the industrial spirit in the temporal system: it in like manner saves the legists and the military class from sterile conflict, and points out the radical incompatibility between the military system, which the legists can only revile, and the characteristic nature of modern civilization. Remembering, therefore, these considerations, that we may avoid supposing the two movements to be unconnected, we may now, seeing them to be heterogeneous and convergent, critical and organic, proceed to consider them separately; taking the critical process first, by reviewing the growing disorganization of the theological and military system for the last five centuries.

Necessity of a transitional state.

The negative character of this great revolutionary operation naturally arouses a sort of philosophical repugnance, which must be met by the consideration that this social phase, with all its errors and disorders, is as necessary in its intermediate place as any other to the slow and laborious progress of human development. The ancient system was irrevocably doomed: the new elements were in course of disclosure: but it must be long before their political tendencies and their social value could be verified, so as to form the basis of a new organization. An immediate substitution of the new for the old was therefore impossible, even if there had been no existing human feelings and interests connected with the past: and it was necessary for modern society to go through the process which we now find ourselves in the midst of—through that thoroughly exceptional and transitional state, in which the chief political progress must be of a negative character, while public order is maintained by a resistance ever becoming more retrograde. The revolutionary doctrine which is the agent of the change does its work by exhibiting the insufficiency of the old organization, and protecting the elements of progress from the interference of old impediments. Without the impulsion of this critical energy, humanity would have been stationary; and its office could not have been fulfilled if the critical movement had not been urged to its last natural degree, and especially in its mental action; for nothing short of the entire suppression of the religious and political prejudices relating to the old organization could have saved us from a series of fruitless attempts at modifying what was fit only for dismissal. Such a preparation of the ground may be considered a negative condition; but it is an indispensable one; and all repugnance attendant upon the spectacle of destruction ought to give way before this consideration.

Its commencement.

For the date of the beginning of this disorganization, we must go back further than the time usually assigned, which is the sixteenth century. The Catholic constitution had, however, fulfilled its office before the end of the thirteenth century, while, at the same time, the conditions of its political existence had become seriously impaired. I therefore fix on the opening of the fourteenth century as the origin of the revolutionary process, which has, from that date, been participated in by every social class, each in its own way. In the spiritual domain, Catholicism transcended its bounds, during the pontificate of Boniface VIII., by setting up an absolute domination, which of course excited universal resistance, as formidable as it was just, at the very time when it had manifested its radical incompetency to direct the intellectual movement, which was becoming of more social importance every day. Serious precursory symptoms of decline began to appear; such as the relaxation of the sacerdotal spirit, and the growing vigor of heretical tendencies. The Franciscans and Dominicans, whose institution was then a century old, were as powerful a reformatory and preservative power as the system admitted; and they effectually counteracted the decay for a time; but their power did not long avail; and the very necessity for its use was a prediction of the speedy downfall of a system which received such a support in vain. Another symptom was the violent means resorted to on a great scale for the extirpation of heresies; for as spiritual authority can finally rest only on the voluntary assent of men's minds, all resort to material force is an unquestionable token of imminent and conscious decline. These indications assign the opening of the fourteenth century as the date of the concussion received by the Catholic system in its most central prerogatives.

In the temporal order, in the same way, the feudal system fell into decay because it had fulfilled its military office. Two series of efforts had been required during the defensive period,—one to guard the uprising civilization from the incursions of the wild polytheists of the north, and the other to protect it from Mussulman monotheism. In the first, the great hero of the Middle Ages found a field for his energy; but the struggle was harder in the second case. Catholicism could put the seal on the conquest of the northern nations by converting them; whereas, there could be no conversion where the hostile powers were both monotheistic, and each insisting that his form of monotheism should prevail. The great result of the Crusades, among many which have engrossed more attention, was that they preserved the Western progression, and remanded the Mussulman proselytism to the East, where its action might be really progressive. The success of the Crusades could not be complete till the Northern migrations had been brought to an end by stout resistance and wise concessions: and this is why the defence of Catholicism against Islamism became the chief object of military activity during the two centuries when the Middle Age polity was in its perfection. The great defensive operation may be regarded as complete toward the end of the thirteenth century, though there were occasional irruptions from the East till the seventeenth, and the habit of crusading excitement required time for subsidence. When the protective and conservative office of the feudal *régime* was accomplished, the military spirit became disturbing; and the more so as the European authority of the papacy declined. Its services were partial, in guarding the nationality of the various European peoples; but then it was through this very military spirit that those nationalities were endangered. It declined, together with the spiritual power, when its political ascendency would have stood in the way of progress.

Division of the critical period.

In any scientific analysis of the whole critical period of five centuries,—from the fourteenth to our own,—the period must be divided into two parts; the first comprehending the fourteenth and fifteenth centuries, in which the critical movement was spontaneous and involuntary, without any intervention of systematic doctrine; and the other comprehending the last three centuries, during which the disorganization has proceeded under the growing influence of an avowedly negative doctrine, extended by degrees to all social ideas, and indicating the tendency of modern society to renovation, though the principle of renovation has remained undisclosed.

By what has gone before, we see that the critical doctrine was not, as is commonly supposed, the cause, but the effect, of the decay of the system that was passing away. And nothing exhibits so plainly the provisional character of the Catholic *régime* as the spectacle of its sinking under the mutual conflict of its own instruments, without any systematic external attack: but the decay is not difficult to account for, after what we have seen of its germs, included in the organism in its best days, and sure to grow with a rapidity proportioned to its decline.

Causes of spontaneous decline.

The separation between the spiritual and temporal power was itself a cause of decline, both from the want of conformity of the existing civilization, and from the imperfection of the only existing philosophy. The military spirit is always aiming at exclusive rule, even when it has arrived at the defensive stage of character; and therefore the division of authority, desirable and useful as it was, was a premature attempt at what can be fully accomplished only when the industrial spirit shall have completely superseded the military. The theological spirit was no less disposed to pass its limits, the sacerdotal boundary being moreover thoroughly empirical and indeterminate. The mental discipline, which became more and more stringent and oppressive as the necessary convergence became more difficult, strengthened the sacerdotal disposition to usurpation. Again, though the temporal dominions annexed to the papacy became important among European sovereignties only when the Catholic system was in a state of political decline, the temporal sovereignty no doubt aided the spirit of ambition in the popes. Between an imperfect civilization on the one hand and a vicious philosophy on the other, the fundamental division which it was the glory of the period to have proposed, was overthrown; and the wonder would be that it lasted so long as to the fourteenth century, if we had not seen how slow and feeble was the growth of the new social elements, and how much remained to be done, to the last, before the function of the Catholic and feudal system was fulfilled. Our conclusions will be the same if we study the principal subdivision of each of these main powers: that is, the corresponding relation between the central and the local authorities. We shall see that the interior harmony of each power could have no more stability than their mutual combination. In the spiritual case there was a stronger peril of discord between the central sacerdotal authority and the national clergies, than always attends upon human imperfection. The system had special liabilities of its own. When the severe discipline necessary to preserve unity in the Church began to react, any partial rebellion might become important by attaching itself to national rivalries, under the guardianship of the respective temporal powers. The same causes which limited the territorial extension of Catholicism were fatal to its interior constitution, quite apart from dogmatic difficulties. In the most favoring countries the national clergy claimed special privileges, which the popes declared to be incompatible with the political existence of Catholicism; and the opposition was doubtless as real in more remote countries, though less formally expressed. At the same time the papal tendency to centralization, which indulged Italian ambition at the expense of all other, aroused very energetic and obstinate national susceptibilities on every hand. Thus there was danger of a breaking-up, from the formation of independent national Churches before doctrinal schism was heard of. Considering the liabilities of such a system, and the imperfection of its intellectual bases, it is clear that no excellences of organization could preserve it from decay when once its discordant forces were set free from their combined pursuit of a common end; that is, when the system had once reached its culminating point. As for the temporal case, we are all familiar with the struggles between the central power of royalty and the local powers of the various classes of the feudal hierarchy. No efforts to reconcile the contradictory tendencies of isolation and centralization, both of which were sanctioned by the feudal spirit, could possibly avail for any length of time; and the ruin of the system must follow upon the victory of either of them.

The spectacle of this spontaneous decomposition suggests the reflection, first, that it confirms the estimate in the last chapter of the transitoriness of this extreme phase of the theological and military system; and again, that as the spontaneous decay was favorable to the growth of the new social elements, it becomes a fresh evidence of the fitness of the *régime* to carry on the great human evolution; and again, that the spontaneousness of the decay is really a distinctive feature of the Catholic and feudal *régime*. inasmuch as it was far more marked than in any preceding instance. In the spiritual order, carefully organized as it was, it is remarkable that the first agents of disorganization always and everywhere issued from the body of the Catholic clergy; whereas, there was nothing analogous to this in polytheism, in which the two powers were confounded. So provisional is the theological philosophy, that, in proportion as it advances, intellectually and morally, it becomes less consistent and less durable,—a truth which is confirmed by all historical observation. Fetichism was more deeply rooted and stable than polytheism, yet gave way before it. Polytheism had more intrinsic vigor and a longer duration than monotheism; and this appears, on ordinary principles, thoroughly paradoxical; while our theory explains it all by showing that the rational progress of theological conception consists in a perpetual diminution of intensity.

Decline under negative doctrine.

Turning now to the second period,—that in which the destruction of the old system proceeded under the superintendence of a systematic negative doctrine,—we must bear in mind what I have already said of the indispensable need of such a doctrine, to shelter the growing germs of the system to come, and to obviate the danger of eternal fruitless conflict, or of a return to an exhausted *régime*. As to the inevitableness of such a negative doctrine, that is easily established: for instance, we see it to be certain that Protestantism must arise, in course of time, from the very nature of the monotheistic *régime*. Monotheism introduced into the very heart of theology a spirit of individual examination and discussion, by leaving comparatively unsettled those secondary matters of belief which polytheism dogmatically fixed to their last particulars; and thus a natural though restricted philosophical liberty was admitted, at least to determine the proper mode of administering the supernatural power in each particular case. Thus theological heresy is impossible in polytheism, and always present in monotheism; because speculative activity must fall into more or less divergence with regard to essentially vague and arbitrary conceptions; and the division between the spiritual and temporal powers greatly enhanced the tendency in the case of Catholicism, because it incited free inquiry to extend itself from theological questions to social problems, in order to establish among them the special applications of the common doctrine which could be proved legitimate. The tendency gained strength perpetually during the whole period of the decay of the system, while the temporal powers were fighting against the spiritual, and the national clergies against the papacy; and we see in it the origin of the appeal to free inquiry which characterizes Protestantism, the first general phase of the revolutionary philosophy. The scholars who supported the authority of kings against the popes, and the national Churches which resisted the decisions of Rome, could not but claim for themselves a right of inquiry, urged more and more systematically, and unavoidably extended to all individuals and all questions, till, by mental and social necessity, it brought on the destruction of the Catholic discipline first, then of the hierarchy, and, finally, of the dogma.

The provisional philosophy.

As for this character of the provisional philosophy, it is determined by the nature of its function. Popular sense has given its character in its title of Protestantism, which applies to the whole revolutionary philosophy, though commonly confined to the first state of the doctrine. In fact, this philosophy has, from the rise of primitive Lutheranism up to the deism of the last century, without excepting the systematic atheism which is its extreme phase, been nothing more, historically speaking, than a growing and increasingly methodical protest against the intellectual basis of the old social order, extended, in virtue of its absolute character, to all genuine organization whatever. Serious as are the perils attending this negative spirit, the great necessary renovation could not take place without it. In all preceding times the destruction of each form could be subordinated by the human mind to the institution of a new form, which had some perceived character and purpose; but now a total renovation was needed,—a mental as well as social renovation,—more thorough than the experience of mankind can elsewhere show. As the critical operation was necessary before the new elements were ready, the ancient order had to be broken up, while the future remained wholly unsettled; and in such a case there was nothing for it but giving an absolute character to critical principles; for, if any conditions had been regularly imposed on the negative rights which they proclaimed, such conditions must have been derived from the very system proposed to be destroyed (no other social system being then in view), and thus the whole work would have been a mere abortion. The critical dogmas concerned in the process I shall notice hereafter, more or less explicitly; meantime, I have so exhibited the grounds of the hostility and defiance manifested by this negative philosophy toward all authority whatever, and of its instinctive and absolute tendency to control and reduce all social powers, and both the origin and aim of such tendencies, that the thoughtful reader may obtain for himself the elucidations which it is not within my scope to provide.

Christian period of the doctrine.

One more division remains to be made—of the last period of three centuries into two nearly equal portions. In the first, which comprehends the chief form of Protestantism, properly so called, the right of free inquiry, while fully admitted, was restrained within the limits of the Christian theology; and, in consequence, the spirit of discussion was chiefly employed in destroying, in the name of Christianity, the admirable system of the Catholic hierarchy, which was, in a social sense, the only thorough realization of it. In this appeared conspicuously the inconsistency which characterizes the whole of the negative philosophy, proposing, as we here find it, to reform Christianity by destroying the indispensable conditions of its existence. The second phase presents the various schemes of deism which constitute what is called the philosophy of the eighteenth century, though its methodical formation really belongs to the middle of the preceding century. In this case the right of free inquiry was declared to be indefinite; but it was taken for granted that metaphysical discussion would remain within the general limits of monotheism, whose foundations were supposed to be unalterable. They

Deistical period.

were, in their turn, however, broken up before the end of the period, by a prolongation of the same process. The intellectual inconsistency was notably diminished by this extension of the destructive analysis; but the social dissolution appears more evident, through the absolute disposition to establish political regeneration on a series of mere negations, which can produce nothing but anarchy. It was through Socinianism that the historical transition from the one phase to the other was made. Our preceding survey explains enough of the origin and formation of these two phases; for it is evident that, in the first place, the right of free inquiry must have appeared to be limited, or it would not have been admitted; and in the next, its limits could not but be found to be moveable; and the extravagances and disturbances which were sure to ensue must have compelled the strongest minds to withdraw altogether from an order of ideas so arbitrary and discordant, and therefore so perverted from their original destination. The distinction between the two phases is so indispensable that, notwithstanding their extension among all the peoples of Western Europe under forms which, though various, are politically equivalent, they could not have the same principal seat, as we shall see hereafter. There was also a difference between them as to their share in the new social elements; for the positive spirit was at first too restricted and concentrated, as to topics and minds, to have much effect on the advent of Protestantism, which, on the other hand, rendered great services to positivism; whereas, under the second phase, the powerful though indirect intervention of positivism imparted a rational consistency to anti-theological analysis which it could not otherwise have obtained, and which will prove to be the chief basis of its ulterior efficacy.

The course of progress during the whole five centuries encountered no serious opposition, except from the legitimate apprehension of an entire overthrow of society; and it was this fear which imparted such energy as there was in the resistance of the ancient powers, which were themselves drawn in to participate, directly or indirectly, in the universal unsteadiness. The leaders of the movement were necessarily placed in a position of extreme difficulty, and especially after the sixteenth century; their office being to satisfy the needs of both order and progress, which became imperative in proportion as they were found to be nearly irreconcilable. During the whole period, the highest political capacity was that which could most wisely carry on the steady demolition of the ancient system while avoiding the anarchical disturbances which were always imminent where the critical philosophy was at work. The ability to derive social benefit from the spirit of logical inconsistency was quite as important and quite as delicate as that which is so much honored for its beneficent social application of the theological doctrine, in the preceding ages. At the same time, the social success of the critical doctrine, in spite of its extreme logical imperfection, shows its accordance with the needs of the time;

but for which the success would be inexplicable. We must therefore regard this memorable critical movement as being no accidental disturbance, but one of the necessary stages of the great social evolution, however serious are the dangers involved in its irrational protraction to the present day.

Organs of the doctrine.

When we study the organs of the operation which we have surveyed in the abstract, we shall find it difficult or impossible to follow up, steadily and clearly, the separation between the spiritual and temporal power, though at intervals, we shall find it reappear, under all the main aspects of modern civilization. One division, however, among the social forces which superintended the transition of the last three centuries, is naturally distinct enough,—that between the metaphysicians and the legists, who are, in some sort, the spiritual and temporal elements of the mixed and equivocal *régime* that corresponds with the inconsistent and exceptional social condition of the period. Both must necessarily arise, as I shall show, from the respective elements of the ancient system,—the one from the Catholic, and the other from the feudal power,—and grow up in rivalry to them first, and then in hostility. Their rise is plainly distinguishable in the reason of the greatest splendor of the monotheistic *régime*, especially in Italy, which was always foremost in the Middle Ages, and in which the metaphysicians, and also the legists, were rising in importance, from the twelfth century,—chiefly in the free towns of Lombardy and Tuscany. Their character and office could not however be fully revealed till the rise and spread of change called for their intervention in laying the foundations of the exceptional system which they have since administered. They found their instrumentality in the universities and parliaments, which have been from that time the organs of the metaphysical action and of the power of the legists. The Heads of faculties or doctors, who represented the metaphysical power, produced the men of letters as a secondary class; and the legists, in like manner, yielded an accessory class in the judges and lawyers. We shall see hereafter how the secondary classes have now obtained the ascendency, thereby indicating that the end of this singular anomaly is near at hand.

Scholasticism.

Fixing our attention now upon the spiritual element which continues to be the most characteristic, even in this case,—we have seen how the metaphysical spirit must naturally obtain social sway at this period. After the Greek division of philosophy into natural and moral, the metaphysical spirit assumed two forms, which, in harmony with the distinction, became gradually antagonistic. The first, of which Plato must be considered the chief organ, most resembled the theological philosophy, which it at first tended rather to modify than to destroy. The second, whose type was Aristotle, approached much nearer to the positive philosophy, and tended to disengage the human understanding from all theological guardianship. The one was critical only on the side of polytheism, and superintended the organization of monotheism, under which it was itself absorbed by the theological spirit, and transmuted into religious philosophy: whereas, the other, occupied at first with the study of the external world, could not but be altogether critical, from its anti-theological tendency, in combination with its total lack of power to produce any organization whatever. It was under the direction of this last that the great revolutionary movement went on. Discarded by Platonism, while the best minds were engaged in the organization of the Catholic system, the Aristotelian spirit, which had been perpetually extending its inorganic domain, began to assume the ascendency in philosophy, by gradually comprehending the moral, and even the social world under its sway, as soon as the need of a rational philosophy began to prevail. It was thus that, after the twelfth century, when the monotheistic system was in its glory, the growing triumph of scholasticism was actually working the destruction of the theological philosophy and authority. It assumed consistency from its natural aptitude for engrossing public instruction in the universities, which were no longer devoted to ecclesiastical education alone, but embracing all the chief kinds of intellectual culture. The works of Thomas Aquinas, and even of Dante, show that the new metaphysical spirit had invaded the whole intellectual and moral study of individual Man, and was already extending to social speculations so as to indicate the approaching emancipation of human reason from all purely theological guardianship. The canonization of the great scholastic doctor was his due for his eminent political services; but it shows the involuntary implication of the popes in the new mental activity, and their prudence in incorporating with their system whatever was not directly hostile to it. At first, the anti-theological character of metaphysics could disclose itself only in the form of a livelier and more pertinacious heresy and schism: but the great decisive struggles of the fourteenth and fifteenth centuries against the European power of the popes and the ecclesiastical supremacy of the papal see, occasioned a large and permanent application of the new philosophy to social questions. Having attained all the speculative perfection it admitted of, it entered henceforth more and more into political controversy; and, as it grew more negative in regard to the old spiritual organization, it became necessarily destructive also of the corresponding temporal power, which it had at first stimulated in its universal encroachments. Thus it is that, up to the last century, the metaphysical power of the universities came to take the lead in the work of destructive change. When we hereafter review the results of the movement, we shall find abundant light cast upon the analysis here presented.

The Legists.

If we turn to the corresponding temporal state, we can now see how necessary was the relation, in regard both to doctrines and persons, between the class of scholastic metaphysicians and that of the contemporary legists. Through the study of ecclesiastical law, the new philosophical spirit must enter into the study of social questions and of law in general; and next, the teaching of law must be a privilege of the universities; besides that the canonists, properly so called, who were the immediate offspring of the Catholic system, were the first order of legists subjected to a distinct organization. The affinity of the two orders is so marked that it might be natural to look upon the legists as metaphysicians passed from the speculative into the active state: but they are not so; but rather an emanation of the feudal power, whose judiciary functions fell into their hands: and their hostility to the Catholic power was naturally for ever on the increase through the collisions between the ecclesiastical tribunals and the civil jurisdictions, royal and seigneurial. They began to be powerful before the decline of the Catholic system; their influence increased during the absence of the feudal chiefs in the Crusades, from the judiciary administration of affairs at home remaining in their hands; and the great conflicts of the fourteenth and fifteenth centuries opened boundless scope and congenial employment to their activity. This was the season of their highest triumph, because their political ambition was then in harmony with their real service in aid of human progression: and, in regard to both classes, this was the age of lofty intellect and noble character. When this new social element had sufficiently aided, first, the efforts of the kings to free themselves from the control of the popes, and then, the opposition of the national churches to the papal supremacy, it had done its highest work on behalf of modern society, and had little more to do than to guard the results obtained from the always threatening reaction of the discomfited forces of the old organization. What its later action has been, we shall soon have occasion to observe. All that I need point out here is that, as these two bodies never had any organizing principle or power, their sway could be only temporary, and for purposes of mere preparation for a future organic state; and that such social order as was preserved during their rule must be attributed to the resistant action of the ancient powers, which still retained the direction of the society, though more and more encroached upon by revolutionary modifications. If led to any attempt to construct and organize, the metaphysicians have no other resort, for principles and materials, than to the theological system, nor the legists than to the military system, which it is their very function to discredit and destroy; and thus, we know by anticipation that their power must expire with the last remains of the ancient *régime*.

Having surveyed the revolutionary movement of modern society in its nature, its course, and its organs, we have now only to observe its fulfilment.

Period of spontaneous spiritual decline.

The spontaneous stage of the spiritual decay is the first aspect which claims our attention, because it brings after it all the rest. It was not only the first to be fulfilled, the most difficult and the most decisive; but it involved the ruin of the whole *régime*. The efforts of the kings to overthrow the European power of the popes, which constitute the first aspect of the decline, may be referred to the fourteenth century, beginning with the strong reaction of Philippe-le-Bel, followed by the translation of the Holy See to Avignon: while the fifteenth century is the date of the second series of efforts,—that of the national churches against the papacy; beginning with the schism which arose out of the removal of the Holy See, and strengthened by the impulse imparted by the spontaneous union of the various churches against the papacy, in the celebrated Council of Constance. The first movement was essential to the second; as the national clergies could not place themselves under the direction of their respective chiefs till the chiefs themselves had escaped from the papal thraldom. Of all revolutionary operations, this appears to me to be the greatest; for it broke up the foundations of the monotheistic *régime* of the Middle Ages, by occasioning the spiritual power to be absorbed by the temporal. The kings were blind to the consequences of their own acts when they destroyed the intellectual and moral foundations of the supremacy which they hoped to usurp, but which was effectual only in virtue of being independent of temporal power; and the various clergies, striving for nationality in order to escape from Romish centralization, were unaware that they were degrading their order by passing over from the authority of a single natural head to that of a multitude of military powers whom they must regard as their spiritual inferiors;—thus placing each church in an oppressive state of political dependence, through their own desire for an irrational independence. The reaction of these movements upon the popes tended to aggravate the injury to the Catholic constitution. From the middle of the fourteenth century, when the sagacity of the popes assured them of the approaching emancipation of the kings in England, France, etc., while the eagerness of the national clergies in supporting all restrictions on papal power indicated their approaching nationalization, it is evident that the popes began to occupy themselves with their principality, which had before been merely an accessory object of solicitude, but which was now becoming the only real part of their political power. Before the close of the fifteenth century, the ancient chief of the European system had sunk down to be the elective sovereign of a part of Italy, no longer ruling the civilized world, but striving for his own territorial aggrandizement, and to obtain a royal station for the long series of pontifical families, so as to make the absence of the hereditary principle almost an evil in the midst of this flood of nepotism. The papal power was now merely Italian: it had abdicated its noblest political attributes: and it lost its social utility, so as to become, more and more, a foreign element in the constitution of modern society. Hence dates the retrograde character of the Catholic polity, which had been so long progressive. Thus it was that all the essential elements of the Middle Age polity concurred, in their several ways, in the irrevocable decline of the spiritual power, which constituted its strength and dignity. And thus it is clear that the first disorganization was almost accomplished before the advent of Protestantism, which was its result and not its cause, whatever may have been the subsequent influence which flowed from its systematic sanction of the demolition of the Catholic system.

Indispensable as this demolition was, it left an immense gap in the body of European polity, the elements of which were now delivered over to conflict without restraint. A melancholy example of this is afforded by the frivolous and fierce wars of the principal countries, and especially by those between England and France, while the unavailing efforts of the popes to make peace proved merely that their European authority was gone. An exuberant military activity remained over from the system of defensive war; and the protracted ascendency of the military caste united with it to give that strange character to the wars of the period which contrasts so unfavorably with the social interest of wars of an earlier time, and even with that of the religious wars of the next century. The evils of the situation were aggravated by the decline, at the same time, of the political influence which had hitherto regulated international relations. Two centuries before, the papacy had struggled successfully with a similar difficulty: but now it was decrepit. Its period of splendor was not long gone by, and its will was ardent and sincere as ever; but, in accordance with, and in proof of its temporary character, it failed utterly in its political vocation, through no accidental obstacles, but in consequence of its early disorganization. We shall soon see by what provisional expedient modern polity endeavored to supply, as far as possible, this vast defalcation.

Spontaneous temporal decline.

The disorganization of the temporal system, though proceeding throughout the thirteenth century, could not show its effects while the Catholic system remained unimpaired: but no sooner did the spiritual system begin to fall asunder than there was such disorder in the temporal as threatened the entire subversion of the feudal system, by destroying the balance of powers of the kings and the nobles. The local force of the nobles had, before the end of the fifteenth century, almost entirely absorbed the central force of the kings, as well as the spiritual power,— an inevitable consequence of the rise of the industrial spirit, and the attendant antipathy to the old military temper. It may seem as if the struggles of that time showed anything but a release from a military state of society: but, in fact, such wars as were taking place were fatal to the social consideration of the dominant military class, who, in warring against the civilization which it had been their function to protect, were manifesting the most unquestionable of all symptoms of decay,— that of turning against their original aim. The feudal organism was near its end when, instead of restraining the system of invasion, it became the general invader. The memorable institution of standing armies, begun in Italy and fully developed in France, marked the complete dissolution of the temporal system of the Middle Ages, both by manifesting the repugnance of industrial society to feudal service, and by substituting a wholly new military subordination for that of feudal warriors to their chiefs. The change was highly beneficial to industry; but it deprived the ancient military caste of its special prerogative. In this process of change, the gain was certain to be on the side of the kings. When the balance was once destroyed, the nobles were sure to be the sufferers, from the encouragement that the feudal system offered to the growth of the central power. As the decline of the spiritual power wrought in the contrary direction,—that is, against the kings,—all Europe would have been in a state of complete dismemberment, but for the advantage given to the central power by the temporal dissolution. Of the few exceptional cases of the political ascendency of the aristocracy over royalty, the most remarkable is that of England; and that it is an exceptional case should be well understood by those who would transplant the temporary system peculiar to England to the continent, with the idea that the work of political renovation was then complete. The case and polity of England are perfectly singular, owing, I think, to the two circumstances of her insular position and the double conquest she has undergone; the first admitting of an undisturbed course of social development; and the other provoking a coalition of the nobles against royalty, as a result of the Norman conquest. Moreover, that conquest, by its results, favored the combination of the aristocratic league with the industrial classes, by means of the valuable intermediary class of the Saxon nobles; an intervention which existed nowhere else. As it does not accord with the abstract character of my inquiry to go further into detail, I must content myself with referring the reader to the case of Scotland, in proof that the double conquest had more influence than insular position in determining the peculiarity of the English case; and to those of Venice first and afterward of Sweden, as instances of the political development of which England is the most striking example.

Thus, toward the end of the fifteenth century, we see that the spiritual power was absorbed by the temporal; and one of the elements of the temporal power thoroughly subordinated to the other: so that the whole of the vast organism was dependent on one active central power—generally royalty—when the disintegration of the whole system was about to become systematic. I have already said that the process occupied two periods, the protestant, properly so called, and the deistical.

True character of the Reformation.

After what we have seen, we shall easily understand that the Reformation simply put the seal on the state of modern society, such as it was after the changes, particularly of the spiritual power, of the two preceding centuries. The revolutionary condition, I must observe, was as marked among the nations who remained Catholic, as among those who professed Protestantism; though the characteristics of the change were different. The subordination of the spiritual power affected all the West of Europe, and all orders of persons who inhabited it—priests and popes, as well as kings, nobles, and people. When Henry VIII. separated from Rome, Charles V. and Francis I. were almost as fully emancipated as he. The two points of change which alone have remained common to all sects were the breaking up the centralization of the papal power, and the national subjection of the spiritual to the temporal authority: and the achievement of Luther, with all its stormy grandeur still investing it, was in fact a simple realization of this first stage of Catholic decline; for its dogma was at first a collateral affair; and it essentially respected the hierarchy, and seriously attacked only the discipline. If we look more closely at the nature of the changes, we shall find them such as not only propitiated the human passions which exist in clergy as in other men, but confirmed the destruction of sacerdotal independence—namely, the abolition of clerical celibacy and of general confession. Such being the earliest character of Protestantism, it is easy to see why it made its first appearance among nations remote from the centre of Catholicism, and to whom the Italian tendencies of the papacy during the last two centuries were especially vexatious. At the same time (the time of Luther), the kings of Catholic countries—of France, Spain, Austria, etc.—were as completely the masters of their clergy, and as completely independent of the papal power, as the Protestant princes, though they did not openly arrogate to themselves a useless and absurd spiritual supremacy. But the Lutheran movement, especially when it had reached the Calvinistic phase, wrought powerfully in converting the clergy to such a political subjection, which had been repugnant to them before, but in which they now saw the only security for their social existence amidst the universal passion for religious emancipation. It was then that the coalition of social interests began, between Catholic influence and royal power, which has been erroneously attributed to the best days of Catholicism, when that system was in fact glorious for its antagonism to all temporal power. It is another mistake to suppose that the opposition to human progress is more attributable to modern Catholicism than to Lutheranism, which, in its English or Swedish or any other form, is yet more hostile to progress, having never proposed to be independent, but been instituted from the beginning for perpetual subjection. From whatever cause, the Catholic church, finding itself powerless in regard to its highest offices, and restricted to the control of the individual life, with some little remaining influence over the domestic, has applied itself more and more exclusively to the preservation of its own existence by making itself a necessary auxiliary to royalty, in which alone the remains of the life of the monotheistic age were concentrated. It needs no showing that this was a vicious circle, out of which nothing could issue but ruin both to Catholicism and to royalty. Catholicism offered itself as a support precisely because it was itself in need of support; and it lost its popular credit by thus renouncing its ancient and most prominent political office, retaining only the empty power of preachment, which, however sublime in eloquence, was essentially declamatory, and very inoffensive to the now superior power. At the same time, royalty had connected its political fate with a system of doctrines and institutions certain to excite in time universal repugnance, intellectual and moral, and doomed to universal and speedy dissolution.

The Jesuits.

The dissolution was systemized, from the beginning, chiefly by the institution of the society of the Jesuits, which, eminently retrograde in its nature, was founded to serve as a central organ of Catholic resistance to the destruction which threatened on every side. The papacy, of late chiefly engrossed by the interests and cares of its temporal sovereignty, was no longer fit for the necessary opposition to spiritual emancipation; and the Jesuit leaders, who were usually eminent men, assumed, under all modest appearances, the function of the popes, in order to bring into convergence the partial efforts which were more and more scattered by the tendencies of the time. Without them Catholicism could not, it appears to me, have offered any substantial resistance for the last three centuries; but not the less must the Jesuit influence, from its hostility to human progress, be eminently corrupting and contradictory in its character. It engaged all the social influence it could lay hold of in the service of Catholicism, by persuading the enlightened that their own power depended on their support of a system of sacerdotal authority over the vulgar, while they themselves might enjoy a secret emancipation;—a procedure which was possible only as long as such emancipation was exceptional, and sure to become ridiculous when religious liberty should be more widely spread, when, of necessity, Jesuitism must be reduced to an organized mystification, in which every person concerned must be at the same time and for the same purpose deceiver and deceived. Again, by striving for the direction of education, Jesuitism helped to propagate the intellectual movement; for, however imperfect its teachings, they were an apparatus directed against the end of its own institution. Its famous foreign missions offer the same contradiction between the means; for they offered homage to the intellectual, and especially the scientific, development of modern society, which it was their object to contravene; and derived their own spiritual power from that intellectual teaching which they made the means of introducing articles of faith that they at first were compelled to disown or conceal. I need not point out the perils to which such an institution must have been exposed, holding so exceptional a position amidst the Catholic organism, and by the superiority of its special destination provoking the jealousy of all other religious bodies, whose attributes it absorbed, one by one, and whose antipathy became so intense as to neutralize, in the heart of the Catholic clergy themselves, all regret for the final fall of the only possible support of their Church.

Final decay of Catholicism.

Jesuitism was indeed the only barrier set up, with any chance of success, against the incursions of religious liberty; and the Spanish monarchy, as secluded from heresy, was the only effectual support of Jesuitism. Nothing better than a negative result was given forth by the Council of Trent, as the popes seem to have foreseen, judging by their reluctance to summon and prolong the Assembly, which could only reproduce, after a long and conscientious revision, the Catholic system, with a fruitless admiration of the consistency of all its parts, and the conclusion that, with every conciliatory desire, they could consent to none of the concessions proposed for the sake of peace. I pointed out before that the Franciscans and Dominicans had offered, three centuries earlier, the only real promise of Catholic reformation; and, as they failed, there was no hope. The universal prayer of the Catholic world for the regeneration of the Church had for some time shown that the critical spirit was predominant even there. Thus far advanced toward dissolution, no ground was left to Catholicism but that of resistance to human development; and thus reduced to be a mere party in Europe, it lost not only the power but the desire to fulfil its old destination. Absorbed in the care of its own preservation, degraded by the perpetration of foul and suicidal acts, through its partnership with royalty, and resorting to material repression, its activity of resistance only disclosed its intellectual and moral impotence, and indirectly hastened the decay which it strove to arrest. From the first days of decline to the present—from the time of Philip II. to that of Bonaparte—there has been the same struggle between the retrograde instinct of the ancient organization and the spirit of negative progression proper to new social forces: only the situation was at first inevitable; whereas now it is protracted for want of a philosophy appropriate to the actual phase of human development. It does not follow that Catholicism was not illustrated in its decline by many men of eminence, intellectual and moral; but the number rapidly decreased, and the social decay of Catholicism was made manifest in the very men who most adorned it. The finest logic was employed in defending inconsistencies and humiliations, as in the instance of Bossuet; and the virtues of such men as St. Carlo Borromeo and St. Vincent de Paul had no characteristics which attached them to Catholicism, as must have been the case in earlier times. Their natures must have received an equivalent development, though under a different expression, under any religious sect, or outside of all.

Vices of Protestantism.

We must beware of attributing the vices of hypocrisy and hostility to progress to Catholicism alone. From the moment that Protestantism changed its natural attitude of simple opposition, it shared those vices to the full. Catholicism became retrograde against its nature, in consequence of its subjection to temporal power; and Protestantism, erecting that subjection into a principle, could not but be retrograde in at least an equal degree. For instance, Anglican orthodoxy, rigorously required from the vulgar for the political needs of the coexisting system, could not generate very deep convictions and very high respect among those same Lords of Parliament whose decisions had so often arbitrarily changed various articles of faith, and who must officially claim the regulation of their own belief as one of the essential prerogatives of their order. The forcible repression of religious liberty was, in Catholicism, simply a consequence of its modern disorganization; whereas, it is inherent in the very nature of Protestantism, from its confounding the two kinds of discipline; and it could not but manifest itself as soon as it had the power, as long experience has only too well proved. And this has been the case, not only with primitive Protestantism, through the despotic spirit of Lutheranism toward all that goes beyond it: it has been the case in all the more advanced sects from the moment that power passed into their hands, for however short a time. The deist Rousseau proposed the juridical extermination of all atheists; and he is only a fair exemplification of the doctrines which pretend to tolerance while subjecting the spiritual to the temporal order of affairs.

Before quitting the study of modern Catholic resistance, I must remark that, so far from being merely hurtful to social improvement, as we are apt to suppose, it has aided political progress for three centuries past. Besides its office in preserving public order, of which I have already said enough, we must consider the social benefit that has accrued from its active opposition to the spread of the Protestant movement. The imperfect operation of the spirit of free inquiry must have retarded the emancipation of the intellect, especially among the multitude, by humoring the indolence of proud human reason: and in political matters, Protestantism proposes modifications which, in spite of their insufficiency, keep up a delusive notion of the tendency of society to true regeneration. Thus Protestant nations, after first outstripping their Catholic neighbors, have stood still, in a position further removed than the Catholic nations from any real issue of the revolutionary movement: and such would have been the disastrous state of suspension of the whole civilized world, if it had been all pervaded by Protestantism. Instead of the final organic state being made to depend on the indefinite duration of the old organism in that state of half-decay sanctioned by Protestantism, it is aided by the action of Catholicism in retarding the revolutionary movement, intellectual and political, till it could become decisive in both relations.

Temporal dictatorship.

As for the effect of the critical spirit on the temporal changes of the last three centuries,—we find it at work among the social powers which gathered round the preponderant temporal element, whether it were the royal power, as in France, or the aristocratic power, as in England and some other countries. The only active element in either case was naturally invested with a sort of permanent dictatorship, the establishment of which was so far retarded by religious troubles as not to have been fully characterized till the second half of the seventeenth century, and which remains to this day, notwithstanding its exceptional nature, together with the corresponding social situation; because of the incapacity of the special agents of the transition to conduct it to its issue. This long dictatorship, royal or aristocratic, was at once the consequence and the corrective of the spiritual disorganization

Royal and Aristocratic.

which would otherwise have destroyed society altogether. We shall hereafter see what its influence has been in hastening the development of new social elements, and even aiding their political advent. The operation of the dictatorship, in the one case in England, and in the other in France, is full of interest and instruction. Both have equally broken up the feudal equilibrium; but France, from the predominance of the regal element, is nearer to a permanent settlement than England, with its aristocratic system: and the royal element being more indispensable to the issue than the aristocratic, France has been better able to dispense with a peerage than England with a sovereign; so that the aristocratic power has been more subordinated in France than the regal in England. Royalty in France, isolated in the midst of a people bent on emancipation, has opposed less obstruction to progress than the English aristocracy, who, equally disposed to the stationary or retrograde policy, have more power to sustain it, by their closer connection with the people at large. Again, the principle of caste, which in France has long been confined to royalty, is sustained in England by a great number of distinct families, whose continual renewal maintains its vigor, though its character is certainly not ameliorated by the new additions. However proud the English oligarchy may be of their old historical prerogative of making and unmaking kings, the rare exercise of such a privilege could not affect the spirit of the temporal organization so much as the daring permanent power of making nobles which the sovereigns of France appropriated as long ago, and which they have used so recklessly as to make their noblesse almost ridiculous, since the revolutionary phase began. I must observe in this connection that Protestantism has nowhere, and least of all in England, shown itself averse to the spirit of caste, which it has even tended to restore, by re-establishing, as far as possible, the sacerdotal character, of which the Catholic philosophy had deprived it. For one instance, the spirit of Catholicism, opposed to the principle of caste, and favorable to that of capacity, has always opposed the succession of women to the throne or to feudal authority; whereas official Protestantism, in England, Sweden, etc., has sanctioned the political existence of queens and even of peeresses: a contrast which is the more remarkable from Protestantism having made royalty a genuine national papacy.

In both the cases of temporal dictatorship, Protestantism has done something to retard the disorganization which in other respects it accelerated, by reinforcing the element which was to succumb. In England, and in cases analogous to the English, this was done by means of the national papacy instituted by Protestantism,—a spiritual authority which, without being able to inspire very serious convictions, did for a time partially compensate to the multitude for the loss of the real papal guidance, and hence grew to an excess which occasioned great political convulsion. An equivalent, but opposite result of Protestantism took place on the continent, and even in Scotland, but especially in France, by the noblesse being supplied with fresh means of resistance to the growing ascendency of royalty: and in this second case it took the Presbyterian or Calvinistic form, as best suited to opposition, instead of the Episcopalian or Lutheran form, which is best adapted for government. Hence, violent repression or convulsive agitation, as the two powers alternately struggled to repair their former decline; the mass of the people still, as before, interfering no otherwise than as a natural auxiliary, though certain to obtain a personal interest ere long in the controversy, by means of their co-operation. This appears to me to be the true account of the memorable social troubles of England, France, and all the west of Europe, from about the middle of the sixteenth to the middle of the seventeenth century; and thus is explained the thorough unpopularity, generally speaking, of French Calvinism, which was welcomed by the noblesse as a means of recovering their ancient feudal independence, in opposition to royalty, and which was therefore repugnant to the old anti-aristocratic instinct of the mass of the population.

If we look to the general social effect of the dictatorship of the temporal power, in either of its aspects, we shall find it to be that, when its authority was fully consolidated, it raised up its old antagonist, which, on the other hand, accepted, more or less explicitly, a final political subordination. It was quite natural that it should be so, considering how much alike royalty and aristocracy were in origin, caste, and education, and how congenial they must therefore be, when once their rivalship was brought to an end. From that moment the explanation of any democratic tendencies shown by either was clear enough; for each invariably employed its ascendency in favor of its old rival, and against its steady ally. Such was the attitude of the English aristocracy in regard to royalty, on which it lavished a more and more affectionate guardianship; and such was in France, from Louis XIV. onward, the growing predilection of royalty for its humbled noblesse. It is not to be supposed that these transactions took place for calculated reasons. On the contrary, they were the inevitable results of natural affinities, though the consideration might, and no doubt did, afterward, occur, of the utility of such unions as a means of resistance to the revolutionary movement, which was about to become systematic. We observe here a repetition of the error of the preceding period,—that of mistaking a charge for a support: and here we also recognise the natural term of the spontaneous disorganization which characterized the preceding period, and which was extended into this till the remains of the ancient system were gathered round the element which was to prevail. The dissolution being complete, we shall see the critical action assume a new direction toward a decisive revolution, for which the way was now open. From this juncture, the dictatorship of both kinds assumed the retrograde character which was impossible till the respective positions of royalty and aristocracy were settled; and now was that system of retrograde resistance matured which had been begun by Philip II. under Jesuit inspiration, and against which the whole revolutionary spirit, now also matured, was to be brought to bear.

Rise of Ministerial function

When the kings had ceased to be mere warrior chiefs, and engrossed prerogatives and offices too vast to be wielded by themselves alone, the ministerial function arose,—a new symptom of the times, and a new political power. Louis XI. seems to me to have been (with the exception of the analogous case of Frederick the Great) the last European sovereign who really directed all his affairs himself. Richelieu's elevation was not attributable solely to his personal qualities: for both before and after him, men of a far inferior genius acquired an authority quite as real, and perhaps more extended. Now, such an institution is an involuntary confession of weakness on the part of a power which, having engrossed all political functions, is compelled to abdicate the practical direction of them, to the great injury of its own social dignity and independence. The most striking feature of this new position is the surrender of that military command which was once the primary attribute of sovereignty: and this surrender took place in the seventeenth century, behind some official disguises. In the same way, the aristocratic dictatorship resigned its actual political power and military leadership. The English oligarchy confided its chief prerogatives to ministers derived from the nobility, and chose out of a lower rank the real leaders of military operations, both by land and sea: but in the English case, the change was less marked than in the converse, because the peerage could incorporate its ministers with itself, and thus disguise its own weakness. The Venetian aristocracy had already gone through the same process, though with less remark, because the situation was less conspicuous. It is evident that not only is the decay of the military *régime* signalized by the substitution of standing armies for a feudal militia, but the profession of arms was completely degraded when the ministerial power arose, and was usually exercised by men entirely unversed in war, at the very time that kings were retiring from military command. If any superficial thinker should object that we have had great wars up to very recent times, I need only refer him, for a proof that these recent wars do not indicate a military *régime*, to the difference in position and power, between the greatest of modern generals, who are merely the agents of a jealous and distrustful civil authority, and the ancient generals, especially the Roman, who enjoyed an almost absolute and indefinite empire during the whole course of their operations. The best proof that the modern position of military commanders is no accident, but accordant with the natural course of affairs, is the acquiescence of the generals themselves, who have never yet been deterred by the most irksome conditions from eagerly soliciting the command of modern armies. Nothing can verify more strikingly than such a change, natural and universal as it is, the anti-military character of modern society, to which war is more and more an exceptional state,

Military decline.

the very crisis of which yield only an accessory social interest, out of the military profession.

This view is confirmed by an unprejudiced study of the great modern wars, which are hastily cited in contradiction to it. Generally speaking, these wars in no degree proceeded from any feudal exuberance of military activity, after the abasement of the European authority of the popes. The last wars that can be referred to such an origin are, I think, those belonging to the first half of the sixteenth century, during the rivalship of Francis I. and Charles V., consequent on the French invasion of Italy. That very struggle presently became defensive on the part of France, for the maintenance of her nationality against the dangerous pretensions of Charles V. to a kind of universal monarchy. From that time, Protestantism checked the spirit of conquest by the preoccupation of intestinal troubles, and by assigning a new end and course to military activity, thenceforth connected with the great social struggle between the system of resistance, and the instinct of progression ;—to say nothing at this time of what I shall have to speak of hereafter,—the anti-military tendency of Protestant ways,—encouraging habits of discussion and free inquiry evidently hostile to the commonest conditions of military discipline. To this time then we must refer the origin of the revolutionary wars, properly so called, in which foreign war was complicated with civil conflict, for the solemn sake of an important social principle, by which pacific men were brought into the struggle by the force of their convictions, so that military energy might be very intense and sustained without being more than a mere means, and without indicating any general predilection for military life. Such was, in my view, the new character, not only of the long wars which agitated Europe, from about the middle of the sixteenth to that of the seventeenth century, not even excepting the Thirty Years' war, but of the yet more extended war which lasted from the above period to the peace of Utrecht. No doubt there was ambition of conquest in each case, and the more as the first religious and political fervor declined ; but it was an accessory and not a primary influence. These wars, like the former, bear the revolutionary impress, inasmuch as they related to the prolongation of the universal struggle between Catholicism and Protestantism. There was a further change in the character of the wars of the eighteenth century, in consequence of the humbler aim of the European states,—to maintain the hostile systems in their existing positions, in order to leave scope for the industrial development whose social importance was becoming more and more conspicuous. From that time, military activity was mainly subordinated to commercial interests, till the advent of the French Revolution ; during which, with the exception of a great natural outbreak of war, the military spirit began to undergo a final transformation, which, as we shall see hereafter, marks more clearly than any other its doom of inevitable extinction.

The chief agency in accomplishing the changes that we have

Rise of Diplomatic function.

just seen to be connected with the decline of the military system was that small but very remarkable class,—the diplomatists. This class arose out of the necessity of fulfilling the political relations between different states which the papacy had hitherto taken charge of: and the Catholic constitution supplied its first elements by offering many intelligent and active men, naturally placed at the highest social point of view, without being in any degree military; and we observe in fact, that the diplomatists were for some time taken from the Catholic clergy, some of whom were glad to employ in this way the political capacity which was no longer required by their declining corporation. Though, from circumstances, apparently aristocratic, the spirit of the class is essentially progressive, capacity being always placed in the first rank of personal titles, behind the disguises of official forms: and there has certainly not been in Europe, for three centuries past, any other class so emancipated from political and perhaps philosophical prejudices,—in virtue of the superiority of its habitual point of view. This civil class, born and bred side by side with the ministerial power, of which it is a sort of natural appendage, has always wrought well in stripping military leadership of its ancient political prerogatives, reducing it more and more to the condition of an instrument, more or less passive, of designs conceived and directed by the civil authority. It especially contributed to the decline of military power by appropriating the work of negotiation for peace or alliance, which was once an inseparable part of the military function; and this easily explains the instinctive antipathy which has always existed in modern times, under forms more or less expressive, between the higher ranks of the two classes.

This last view leads us on to the final consideration in regard to the temporal dictatorship,—of the efforts which it made to fill up the immense chasm which was left in the political system of Europe by the extinction of the universal authority of the popes. The difficulty arose early in the transition period; but its solution was necessarily deferred; for the only discernible remedy was a regulated material antagonism among the states of Europe; and this could not be had till they had composed their internal troubles, and decided on the character of the temporal dictatorship of each. When that time came the diplomatists went to work with zeal, sustained by a sense of the dignity of their mission, to institute that balance which was rendered necessary by the almost equal division of Europe between Catholicism and Protestantism. The great treaty of Westphalia is a monument of their office in the system of modern civilization, manifesting, as it does, a generous spirit of universal and permanent pacification. The diplomatic solution is, no doubt, very inferior to the old Catholic intervention; for the international organism needs, as much as the national, an intellectual and moral basis, such as the Catholic constitution afforded; and the mere physical antagonism, which was all that diplomacy could establish, could never attain any solidity, and has been of very doubtful utility, if not mischievous, in as far as it afforded scope for political ambition. But it would be unjust to require that a provisional expedient should have the virtues of a normal instrumentality; and the diplomatic function has at least kept alive, among the European states, the idea of some sort of organization, however loose and inadequate, in readiness for the time when a thorough intellectual reorganization shall close the great revolutionary period.

Such was the process of temporal disorganization during the Protestant period; and it was carried out in the same direction, without any essential change, through the deistical period and up to the time of the first French revolution. Here then we may dismiss the first phase of the systematic destruction of the old social system; and, having established the starting-point of the great revolutionary movement, we can proceed all the more rapidly and clearly to estimate the intellectual influence of the Protestant period.

Intellectual influence of Protestantism.

Besides the political action proper to Protestantism, it served as the organ of the universal spirit of emancipation, by preparing for the dissolution, intellectual and social, that the old system must undergo. Though not answerable for the critical doctrine, properly so called, it laid the main foundations of it; and thus the Protestant concussion formed an intermediate situation, which, however transient, could not have been dispensed with. We may consider the whole critical doctrine as reducible to the absolute dogma of individual free inquiry; for this is certainly its universal principle. We have already reviewed, in the first chapter of this book, the operation, individual, social, and national, of this principle; and there can be no dispute about the fitness of Protestantism to lay the foundations of the revolutionary philosophy, by proclaiming the right of every individual to free inquiry on all subjects whatever, notwithstanding the illogical restrictions for ever attempted by itself; restrictions which were, of course, successively rejected by various sects, and which, by their very inconsistency, facilitated the universal admission of the general principle. It was in this way that Protestantism indirectly influenced the nations that had not expressly adopted it, but could not but suppose themselves as well qualified as others for religious emancipation; the greatest philosophical results of which were, in fact, specially reserved for them, as we shall presently see. Now, the universal inoculation with the critical spirit certainly could not operate in a more unmistakable manner; for, after having audaciously discussed the most respected opinions and the most sacred powers, human reason was not likely to recoil before any social maxim or institution, when the process of analysis should be directed that way. Thus, the first step was by far the most important of all that relate to the formation of the revolutionary doctrine.

The principle of free inquiry was at first a simple consequence of the social changes which had been preparing during the two preceding centuries. It was purely negative in its character, being nothing more than a sanction of the state of no-government which intervened between the decay of the old discipline and the formation of new spiritual ties. It was simply an abstract declaration of a general fact; and its existence would otherwise have been incomprehensible. There could never be any hinderance to any one exercising the right, but the restraint of former convictions: and the general proclamation of the will to use the right merely testified to the decay of the restraining convictions. The long discussions of the fourteenth century about the European power of the popes, and that of the following century about the independence of the national Churches, had occasioned a large spontaneous exercise of the right of free inquiry, long before that right was set up in dogmatic form; and the Lutheran proclamation of the dogma was a mere extension to the Christian public of a privilege which had been abundantly used by kings and scholars. Thus, the spirit of discussion which is inherent in all monotheism, and especially in Catholicism, had anticipated, throughout Europe, the direct appeal of Protestantism. Indeed, the Lutheran revolution produced no innovation, in regard to discipline, ecclesiastical orders, or dogma, that had not been perseveringly proposed long before: so that the success of Luther, after the failure of various premature reformers, was mainly due to the ripeness of the time: a confirmation of which is found in the rapid and easy propagation of the decisive explosion. The spirit of personal emancipation was animated by the subjection of the spiritual to the temporal power, which had now taken place for some time; the late rightful guides of opinion and belief were subordinated to incompetent temporal authorities; and when the ancient intellectual prerogatives of Catholicism had passed into the hands of kings, they could not be regarded with the ancient veneration, but must soon yield to that passion for spiritual freedom to which the kings had no objection as long as it did not interfere with material order. And thus was Protestantism, with its dogma of free inquiry, a mere sanction of the pre-existing state to which all Christian nations had been tending for two centuries. Comparing it with the corresponding social state, we shall see it to be the necessary corrective of the temporal dictatorship, in which, as we have seen, the theological and military system had merged. Without it the temporal power would have degenerated into a dark despotism, extinguishing all intellectual and social vigor under the tyranny of an absolute authority which could naturally conceive of no other method of mental discipline than forcible repression. However great the dangers of abuse of the revolutionary doctrine, we can easily understand the invincible attachment of the European peoples to it, when, amidst the consolidation of aristocratic or regal absolutism, it became the organ of social progression. And, negative as was its essential character, it was the fitting and necessary preparation for the establishment of new social elements, from its encouragement of the spirit of individuality, and the consequent development which it caused of personal energy, whether industrial, æsthetic, or scientific. The two great anomalies,—the temporal dictatorship and the revolutionary doctrine,—must be regarded as inseparable, mutually antagonistic, equally necessary for the preservation of society, and together constituting the final phase of the general movement of social decomposition. The one, by its blind reverence for the past, was for ever restraining the innovations of the other; while the absolute character of negation, on which the critical doctrine prided itself, gave it its counteracting energy; and thus they had in common the absolute tendencies which belong alike to the theological and metaphysical philosophies. Thus it is that by an increasing restriction of political action modern governments have more and more abandoned the direction of the social movement, and have contented themselves with the care of material order, which it became increasingly difficult to reconcile with the continuous development of mental and moral anarchy. In sanctioning such a political situation, the revolutionary doctrine has erred only in setting up as a normal and permanent state of things an exceptional and transient phase, to which its dogmas were perfectly suitable.

Catholic share in Protestant results.

Meantime we must not fail to observe the effect of the movements in countries which were not Protestant. The critical action showed itself where the temporal dictatorship was not legally established, by Catholicism solemnly invoking the principle of the right of private judgment in favor of its own faith, which was violently oppressed wherever Protestantism prevailed. Special heresies also arose within the body of the Catholic clergy. France was the main support of the Catholic system in the seventeenth century; yet it was in France that Jansenism arose,—a heresy almost as injurious to the old spiritual constitution as Lutheranism itself. This kind of French Protestantism, ardently embraced by a powerful and respected portion of the clergy, and placed under the active protection of judiciary corporations, would certainly have been erected into a real national religion, if the approaching rise of the pure negative philosophy had not carried the leading minds of the nation far beyond it. As it was, Jansenism showed its anti-catholic tendencies by its antipathy to the Jesuits, whose power it ultimately overthrew; while its reception by great philosophers and eminent poets, who could not possibly be suspected of voluntary revolutionary tendencies, shows how congenial it was to the intelligence of the period. I must give a passing notice to another heresy,—that of Quietism,—which, though much less important than Jansenism, is an equally decisive proof of the dissenting tendencies introduced by the use of the right of free inquiry. The philosophical character of Quietism seems to me remarkable as offering a first solemn and simple protest of our moral constitution against theological doctrine in general. It is only in virtue of such protest that the heresy ever had any consistency, or now has any among some natures whose mental development has not kept pace with the moral.

Jansenism.

Quietism.

All moral discipline founded on a theological philosophy appeals, perseveringly and exorbitantly, to the spirit of selfishness,—not the less for its relating to imaginary interests, which must so engross the solicitude of the believer as to make every other kind of consideration very secondary. This religious supremacy of the care for personal salvation is necessary to the social efficacy of theological morality, which would otherwise issue in a mere sanction of apathy. It accords with the infantine age of humanity, which supposes the theological philosophy to be in the ascendant; and it manifests to all eyes one of the radical vices of that philosophy, which thus tends to starve out the noblest part of our moral organism, and that which by its small natural energy requires precisely the most systematic culture, by the encouragement of the disinterested and benevolent affections. In this view, Quietism is an involuntary exposure of the imperfection of theological doctrines, and an appeal against it to the finest affections of human nature; and it would have been a movement of high importance, if such a protest had not been premature, and framed by the heart more than the mind of the beloved and immortal Fénélon, who was the organ of the heresy. The issue of the controversy involves the death-sentence of the theological philosophy. Fénélon was compelled to admit that he had unintentionally attacked one of the main conditions of existence of the religious system; and any system must be in a state of irrevocable decay that could be so misapprehended by its purest and most eminent champions.

Moral influence of Protestantism.

The moral characteristics and prerogatives of the critical doctrine in their provisional state remain to be noticed. Catholicism had spontaneously abdicated its direction of social morals, virtually, though not avowedly. Without admitting that it had changed its moral doctrine, it controlled only the weak, on whom it imposed passive obedience, while it extolled the absolute rights of rulers, being silent about their duties, even when it did not husband their vices in the interest of the priesthood; and its subserviency, attending upon power of every kind, descended lower and lower among social ranks, spreading its corruption successively among all, till it at length affected even domestic morality. The critical doctrine, insisting upon the rights of those to whom Catholicism preached only duties, naturally inherited the moral prerogatives that Catholicism had abdicated, and all its principles wrought to the same end. The dogma of liberty of conscience revived the great moral obligation, dropped by Catholicism, of using only spiritual instruments in the consolidation of opinions. The dogma of the sovereignty of the people declared the paramount importance of the general interest, too much sacrificed by the existing Catholic doctrine to the ascendency of the great. The dogma of equality roused the universal dignity of human nature, ignored by the spirit of caste, which had outlived its destination and escaped from moral control. And, finally, the dogma of national independence was the only security, after the rupture of

Catholic association, for the existence of small states, and the sole restriction on the tendency to material incorporation. The hostile character of the critical doctrine prevented its fulfilling its great moral office with regularity and in perfection; but it kept alive and in vigor for three centuries a genuine sense of the moral conditions of humanity. It was subject to insurrectionary tendencies, because the temporal dictatorship confided in a system of organized material force; but the insurrectionary tendency was necessary to avoid the moral abasement and political degradation to which modern society was exposed, while awaiting the reorganization which must at length put an end to the deplorable antagonism.

If it were compatible with my object, it would be interesting to show how the views here given of the decline of Catholicism are confirmed by the heresies of modern times. These heresies are the same, under other forms, that arose in the early days of Christianity; and hence the retrograde school would fain derive hopes of the renovation of the system: but the fact that the same heresies which were extinguished by the rising Catholic power have been successful in modern times proves that they were once opposed to the corresponding social state, and that they have recently been in accordance with it. At all times, and in all places, the heretical spirit is inherent in the vague and arbitrary character of the theological philosophy: and it is restrained or stimulated, it fails or succeeds, according to the social exigencies of the time. The reproduction of certain heresies tells nothing; but their success indicates a final change in the conditions of the system from which they arise.

Three stages of dissolution.

It is impossible to enter here upon any detailed account of the Protestant sects, each of which entertained pity for its predecessor and horror of its successor, as the decomposition of the theological system went on. I can only point out the historical principle by which they may be understood and tested, and distinguish the three successive stages of decay of the old system, as regards its discipline, its hierarchy, and its dogma; for, if each Protestant change affected all the three, it must have affected one conspicuously, to be distinguishable from foregoing efforts. The three phases may be indicated by the names of their respective organs, Luther, Calvin, and Socinus, who lived near together as to their years, but at considerable intervals as to their social influence. The dogmatic innovations of Lutheranism were trifling; and it respected the clerical system, except by sanctioning the political subserviency which was only implicit among Catholic peoples; but it overthrew the ecclesiastical discipline, in order to adapt it the better to the servile transformation. This first disorganization, which little affected the Catholic system, was really the only form in which Protestantism has ever been able to adapt itself to be a state religion—at least among great independent nations. To this first demolition, Calvinism added that of the hierarchy which sustained the social

Lutheranism.

Calvinism.

unity of Catholicism, while introducing only secondary modifications into the dogma, though more extensive than those of Lutheranism. This second phase, with its characteristics of mere opposition, without any formative power or organic durability, seems to me to constitute the true normal situation of Protestantism; for the critical spirit discloses itself in antipathy to the inert regularity of official Lutheranism. Then the third action, that of the antitrinitarian or Socinian outbreak, added to the rest of the destruction that of the chief articles of faith which distinguished Catholicism from every other form of monotheism: and arising in Italy, under the very eyes of the papacy, it showed the tendency of the Catholic mind to urge the theological dissolution beyond what had hitherto been attempted by Protestant reformers. This was necessarily the movement which doomed Catholicism beyond recall; but, for the same reasons, it made Protestantism too like mere modern deism to let this phase stand as the representative of the transition, of which Presbyterianism remains, in an historical sense, the special organ. After this, there remains really nothing to distinguish among the multiplicity of sects, in regard to social progress, except the general testimony borne by the Quakers against the military spirit of the old *régime*, when the destruction of the spiritual system by the three instrumentalities just noticed, led to a similar action upon the temporal system. We have seen that the spirit of Protestantism is generally averse to any military system, countenancing war only for the benefit of its own principles: but there is no doubt that the celebrated sect of the Friends, with all its absurdities, and even its quackeries, served as a special organ for that particular manifestation, which places it above all other Protestant sects for the more complete spread of the great revolutionary movement.

Socinianism

Quakerism

Political revolutions of Protestantism

Lest my readers should take, or should suppose that I give, too systematic a view of the process of decomposition, I must remind them that the only way in which Protestantism can be viewed as operating systematically is that it caused the decay to go on under the direction of reforming doctrines, instead of by mere conflict of the old political elements. The formation of the negative philosophy into a system could take place, as far as it was possible at all, only under the deistical phase, whose chief office it was, as we shall see, to effect this. The mental operations of Protestantism were in fact the results and not the causes of the revolutions with which we historically connect them; and no political explosions, whatever their force and their interest on other grounds, could establish the tendency of modern societies to complete renovation till they had been preceded by a thorough and systematic critical preparation, which could not happen except under the following phase. For this reason, I can only barely indicate the purely Protestant revolutions which, apart from their local and temporary importance, could be nothing more than a mere introduction to the great final change destined to open an issue for the general movement of the human race.

Holland.

The first of these revolutions was that by which Holland threw off the Spanish yoke: and it will be ever memorable as a lofty manifestation of the energy proper to the critical doctrine, thus directing the fortunate insurrection of a small nation against the most powerful monarchy in Europe. The dogma specially illustrated in this case was that of the sovereignty of the people, and also that of national independence,—the chief need being to break an external bond which had become intolerably oppressive. A more general character, more complete and decisive, more marked in its direction toward the social regeneration of the race, was the great, unsuccessful English revolution:—

England.

not the little aristocratic and Anglican revolution of 1688, which could meet only a local want; but the democratic and Presbyterian revolution, superintended by the lofty genius of the most advanced statesman that Protestantism has to boast of. It was the dogma of equality which was mainly elaborated under that conflict. Historically the revolution consisted in the generous but premature effort for the political degradation of the English aristocracy,—the chief temporal element of the ancient nationality: and the fall of royalty, under the Protectorate of Cromwell, was only a secondary incident in comparison with the bold suppression of the House of Lords. The social revolution failed politically, for want of due mental preparation; but it was the chief in the whole series of symptoms which were the known precursors of the great decisive European revolution remaining to be examined hereafter.

America.

The American revolution was as purely Protestant as the others, and ought to be classed with them, though its date causes it to be erroneously referred to a more advanced stage of the general movement. It did not volve any new portion of the critical doctrine; and it was simply an extension of the other two Protestant revolutions, but with a prosperous development of political consequences through a combination of favorable conditions. In its origin, it was a reproduction of the Dutch revolutions, and in its final expansion, it carried out the English, which it realizes as far as Protestantism will allow. There is nothing to be said for its success, as a decisive social enterprise; for it has developed to excess the inconveniences of the critical doctrine; it sanctions more emphatically than any other society the political supremacy of metaphysicians and legists, among a people who pay, through their innumerable unconnected modes of worship, without any real social purpose, a tribute more costly by far than the treasury of any existing Catholic clergy. Thus this universal colony, notwithstanding the eminent temporal advantages of its present position, must be regarded as, in fact, in all important respects, more remote from a true social reorganization than the nations from whom it is derived, and to whom it will owe, in course of time, its final regeneration. The philosophical induction into that ulterior state is not to be looked for in America,—whatever may be the existing illusions about the political superiority of a society in which the elements of modern civilization are, with the exception of industrial activity, most imperfectly developed.

Attendant errors.

Subjection of spiritual power.

This sketch of the revolutionary doctrine and its action would not be complete without some notice of its attendant errors. Omitting all merely local and exceptional abuses, I will briefly refer to a few evils which may be called natural to the doctrine. Of these errors the oldest, the most general, and the most mischievous, is the prejudice which condemns in the absolute spirit of the metaphysical philosophy, the political existence of any spiritual power, distinct from the temporal, and independent of it. Inevitable and indispensable as was the temporal dictatorship which followed upon the Catholic period, it could not destroy the value of the principle of the separation of the two powers, the theory of which is the most valuable legacy left us by Catholicism, and the only one on which, when united with a true positive doctrine, the reorganization of society can proceed. As the reorganization must begin, as did the decline, with the spiritual order of power, this absolute spirit, which aims at establishing eternal principles from transient facts, is a serious misfortune; and the more so, of course, from its universality during the last three centuries. From the beginning of the sixteenth century, the revolutionary spirit has assumed this form in its operation upon all classes of society. Protestantism took advantage of the prejudice, though it did not originate it; and the greater part of the Catholic clergy have undergone their political degradation with a growing submission, which has effaced the very memory of their ancient independence. Thus has the main principle of modern civilization,—that of the separation of the two powers,—been lost sight of throughout Europe; and the only appearance of a rational appreciation of it is found among the Italian clergy, where it is of no social value, because of the partiality and self-interest naturally attributed to those who hold it. No adverse influences can however prevent the ultimate recognition of a principle so accordant with the condition and needs of modern society. It will assume its full force when the positive philosophy opens the way to social re-organization. We may attribute to the prevalence of this great error the irrational disdain of the Middle Ages entertained in our time, even by Catholics who do not appreciate the theory of Catholicism; and also the blind admiration for the polytheistic system of antiquity, which prevailed so deplorably during the revolutionary period, though Catholicism had before rightly assigned an inferior position to the civilization of that *régime*: and again, to this error is owing the exclusive predilection of Protestantism for the primitive church, and its yet more injurious enthusiasm for the Hebrew theocracy. The great conception of social progress has thus been overlaid, and well-nigh lost; saved only, as we shall presently see, by that growth of new social elements which has proceeded amidst all the disturbances of the critical period.

Another consequence of the error has been that all ambition, political and philosophical, has tended toward the absolute concentration of the two kinds of power. Kings dreamed of the Mohammedan type as the ideal of modern monarchy; priests, and especially the Protestant clergy, dreamed inversely of a kind of restoration of the Jewish or Egyptian theocracy; and philosophers renewed, under a different form, the primitive Greek dream of that metaphysical theocracy which they called the reign of Mind. The last is now the most dangerous of these dreams, because it seduces the greatest number of active minds. Among the thinkers of the progressive school who have devoted themselves to social speculation, within three centuries, Leibnitz seems to me to be the only one who has entirely escaped the delusion. Descartes would doubtless have done so, if it had lain in his way to state his deliberate view of the subject, as Aristotle alone did in ancient times: but Bacon certainly participated in this illusion of philosophic pride. We shall hereafter consider the serious consequences of this view: and this brief notice of it is merely historical.

Finally, this capital error keeps up a habit of social disturbance by leading men to seek the satisfaction of social needs in change of legal institutions; whereas, in general, the thing wanted is a preparatory reformation of principles and manners. The temporal dictatorship, whether monarchical or aristocratic, was little aware of its own responsibility when it made political questions of all that had hitherto been moral. It matters little that such avidity for power brought on its own punishment: but the results to society have been most disastrous, as we see in a long series of disorders and disappointments, and in the mischievous operations of quacks and fanatics who see, or pretend to see, the solution of all social difficulties in barren political revolutions: and, during the quietest times, in that narrow view which embraces only the immediate redress of social wants, when moral means, extensive and long-prepared, are the true remedy. All political parties agree in proscribing lofty and comprehensive speculation, because all are alike involved in the error which causes the low and material view: and it is only under the positive philosophy that the true solution can be found.

Moral changes under Protestantism.

As for the moral evils engendered by the Protestant introduction of the critical doctrine,—we need not dwell long on them, serious as they are; for they are too evident to require explanation. Considering that every mind was confided to its own decision on subjects the most important, and about which it must be least disinterested, the wonder is that the moral dissolution has not been complete. That it has not been so, —that morality has remained stable in the most evident cases,—is owing first to the spontaneous rectitude of human nature, which it is impossible altogether to corrupt; and next to the power of modern habits of steady toil, which divert the nations of our day from the social extravagances into which, in their position, the idle populations of Rome and Greece would certainly have fallen. Protestantism must be charged with having seriously impaired the fundamental principles of morality, both domestic and social, which Catholicism had established, under precepts and prohibitions which will be sanctioned, in their spirit, more and more emphatically as the positive philosophy prevails. It was a sound observation of Hume's, that the Lutheran revolution was aided by the passions of ecclesiastics who desired a release from celibacy, and the rapacity of nobles who coveted the territorial possessions of the clergy; and it was a necessary consequence of the lowered position of the moral authority, that it lost the power, and even the will, to sustain the inviolability of the most elementary rules of morality against the attacks of the critical spirit. I need point out only the permission of divorce, the relaxation of rules about the marriage of relations; and, as a decisive instance, the disgraceful dogmatic consultation by which the chiefs of Protestantism, with Luther at their head, solemnly authorized bigamy in the case of a German prince; and again, the accommodating temper of the founders of the English Church toward the shocking weaknesses of their strange national pope. Catholicism was never thus openly degraded; but its growing weakness produced nearly equivalent effects. It was unable to repress the license of the time, in public speech and private act; and it so far supported moral excess that it roused a spirit of rebellion against its own authority by its repression of mental development. Thus the various religious doctrines showed themselves inadequate to the moral guidance of mankind; either by using their intellectual liberty to impair the principles of morals, or by proving their impotence to keep moral order; or, by discrediting invariable laws by obstinately connecting them with articles of belief which human reason could never again receive. We shall perceive more and more as we proceed that morality, so far from having any occasion to dread philosophical analysis, can find a solid intellectual foundation only outside of all theology whatever; resting on a rational appreciation of human dispositions, actions, and habits, according to their total results, public and private. It was necessary to say thus much, to mark the period at which religious faith began to lose its power of moral guidance, and to show its tendency, so striking for three centuries past, to promote hatred and disturbance rather than order and charity. We see, now, that the degeneracy dates from the political degradation of the spiritual power, the dignity and purity of the moral laws being deeply impaired by their being subjected to the ascendency of the passions which they were intended to rule.

Stage of full Development of the critical doctrine.

We have now observed the advent of the negative philosophy, and of the corresponding social crisis. The last phase remains to be reviewed,—that which presents the revolutionary doctrine in its full development. This phase, however, is little more than a protraction of the last, and we shall have a sufficient view, generally speaking, of the historical course of the revolutionary philosophy, if we merely attach deistical consequences to Protestant principles. Our attention must henceforth be concentrated on the spiritual disorganization, till we have to notice the great final explosion of the temporal power in connection with the reorganization which will be the closing topic of this Work.

Protestantism opposed to progress.

We give too much credit to human intelligence if we suppose that it could have dispensed with this final elaboration of the critical doctrine, on the ground that its great principles having been furnished by Protestantism, the consequences of those principles might be left to develop themselves without assistance from any systematic formation of negative doctrine. In the first place, human emancipation must thus have been seriously retarded, as we shall admit if we consider how resigned the majority of men are to a state of logical inconsistency like that sanctioned by Protestantism, and especially when the understanding is still subject to the theological system. In countries where the philosophical movement has not fully penetrated the national mind, as England and the United States, we see the Socinians and other sects, which have rejected almost all the essential dogmas of Christianity, persisting in their original restriction of free inquiry within the purely biblical circle, and fostering a thoroughly theological hatred toward all who have pursued their spiritual liberty beyond that boundary. Moreover, it is evident that the expansion of the revolutionary doctrine would have been wholly repressed without the deistical movement which characterized the last century; for Protestantism, after having introduced critical principles, always abandoned them when they could be dispensed with, using its triumph to organize a retrograde system of resistance. It was thus with Lutheranism, which was as hostile to mental liberty as Catholicism; and thus it was with every form of Christianity, according to its power, till the triumph of the Anglican church and the expulsion of the Calvinists from France, gave a systematic character to Protestant discouragement of progress. Protestantism having thus seceded from the progressive movement, which it had hitherto represented, it became necessary that new and more consistent leaders should assume the conduct of the march; and we find in this case the usual correspondence between great social exigencies and their natural means of satisfaction. The Protestant period had brought the ancient social system to such a state of decay that it could not guide, but only impede the formation of modern society, so that a universal and decisive revolution was seen to be impending, by such thinkers for instance as Leibnitz. On the other hand, the system would have lasted for an indefinite time, in its state of decay, and without fulfilling its professions, in virtue of its mere inertia, if the revolutionary ferment, which we shall see more of presently, had not entered in to direct the movement of decomposition toward that regeneration which is its necessary issue. The heretical movement which I before noticed aided the systematic formation of the negative philosophy. We have seen how ancient was the tendency to entire emancipation from theology, as when, in the decline of polytheism, there were Greek schools which speculatively transcended the limits of simple monotheism. At that time, when the very conception of a true natural philosophy did not exist, such an effort could issue in nothing but a kind of metaphysical pantheism, in which nature was abstractly deified; but there was little difference in fact between such a doctrine and that which has since been improperly called atheism; and it resembled it particularly in its radical opposition to all religious beliefs susceptible of real organization,—which is the point that concerns us here, where our business is with negative ideas. This anti-theological disposition was overborne during the long continuance of Catholicism; but it never disappeared entirely, and we see its traces in the whole course of the persecution of the philosophy of Aristotle, in consequence of its sanction of the tendency. We trace it again in the predilection for the freest thinkers of Greece, who indirectly influenced many speculative men, and chiefly among the high Italian clergy, who were then the most thinking portion of mankind. Without actively interfering in the destruction of the Catholic system, the anti-theological spirit was stimulated and expanded by it: and in the sixteenth century, while leaving Protestantism to its work, it profited by the half-freedom afforded by philosophical discussion to develop its own intellectual influence, as we see by the illustrious examples of Erasmus, Cardan, Ramus, Montaigne, and others, confirmed by the artless complaints of true Protestants of the spread of an anti-theological spirit, which threatened the success of their nascent reform by showing forth the decrepitude of the system to which it related. Religious dissent was naturally favorable to the tendency, which ceased to become a source of mere personal satisfaction to leading minds, and extended to the multitude, to whom it served as the only refuge from the fury and extravagance of the various theological systems, which had now degenerated into mere principles of oppression or disturbance. The negative philosophy was, in fact, systemized about the middle of the seventeenth century, and not in the subsequent century, which was occupied by its universal propagation. Its advent was powerfully aided by an intellectual movement, which is perpetually confounded with it, but which is far nobler in nature and destination. The positive spirit had hitherto been concentrated upon obscure scientific researches; but, from the sixteenth century onward, and especially during the first half of the seventeenth, it began to disclose its philosophical character,—no less hostile to metaphysics than to theology, but obliged to ally itself with the one to exclude the other. Its influence arose from its favoring the invasion of faith by reason, by rejecting, provisionally at least, all articles of belief that were not demonstrated. Bacon and Descartes could hardly have entertained any anti-religious design, scarcely reconcilable with the object of their active solicitude; but it is unquestionable

The negative philosophy.

that the preparatory state of full intellectual enfranchizement which they prescribed to human reason must henceforth lead the best minds to entire theological emancipation at a time when the mental awakening had been otherwise in this respect sufficiently stimulated. The result was the more certain from its being unsuspected, for it was the consequence of a simple logical preparation, the abstract necessity of which could not be denied by any sensible man. Such is, in fact, the irresistible spiritual ascendency of revolutions which relate purely to method, the dangers of which can not commonly be perceived till it is too late to restrain them. While the best minds were thus inevitably influenced, the multitude were troubled, at the moment of shaken conviction, by the rising and growing conflict between scientific discovery and theological views. The memorable persecution of Galileo for his demonstration of the earth's motion must have made more unbelievers than all Jesuit intrigues and preachings could retrieve or save,—to say nothing of the exhibition that Catholicism made of itself as hostile to the purest and noblest aspirations of the human mind. Many other cases, less conspicuous but perfectly analogous, brought out this antagonism more and more toward the end of the seventeenth century. In both its aspects this influence, acting on all orders of minds, wrought against the beliefs which contended for the moral government of mankind, and therefore in favor of a final emancipation of human reason from all theology whatever,—the incompatibility of theology with the spread of genuine knowledge being thereby directly revealed.

The ascendency of the negative philosophy was assisted by the good and the bad passions of men, as elicited by the circumstances of the time. The spirit of religious emancipation is closely connected with that of free individual activity; and there can be no doubt that the struggle against the retrograde dictatorship of the seventeenth century roused all the generous passions in favor of the critical doctrine, which, in its systemized condition, was the only universal organ of social progress. On the other hand, negative doctrine, speculative and social, is congenial with the worst parts of human nature. Vanity is pampered by the sovereignty given to every man by the right of private judgment. The term freethinker has been sufficiently abused by theological hatred; but necessary as the title was to express resistance to intellectual bondage, it indicates also that no equivalent is provided for the ancient guidance. Ambition accepts with eagerness the principle of the sovereignty of the people, which opens a political career to all who can achieve it. Pride and envy are gratified by the proclamation of equality, which may be either a generous sentiment of universal fraternity or a hatred of superiority, according to the natures that entertain it. In short, the mental influences which conduced to the formation of the negative philosophy were strengthened by powerful moral influences, tending in their combination to insurrectionary crises, in which there is usually a welcome ready for those who fret under the habitual restraint of social laws.

Three periods.

In surveying the history of the critical philosophy, we must carefully separate the spiritual from the temporal case. The latter was indispensable to the political action of the revolutionary doctrine; but it could not take form till the spiritual function was accomplished. The philosophical emancipation was the most important, because it brought the political after it; and the political could not have occurred without the philosophical. The survey is, in fact, naturally divided into three portions: the first comprehending the systematic formation of the critical doctrine; the second, the universal propagation of the movement of mental emancipation; and the third, the political emancipation, which is the complement of the spiritual.

Systemized.

The first operation, though commonly referred to the eighteenth century, certainly belongs to the seventeenth. Arising out of the most advanced Protestantism, it grew in silence in countries which, like England and Holland, had been chief seats of Protestant change. Its organs, like those of Protestantism, must be derived from the metaphysical school, which had risen to power in the chief universities; but they were genuine philosophers, seriously at work, in their own way, on the whole range of human speculation, and not at all like the mere men of letters of a succeeding age. Three great men led the philosophical revolution,—men mutually unlike and unequal, but concurring in the result;—Hobbes first, then Spinoza, and finally Bayle, who, a Frenchman by birth, was obliged to go to Holland to work freely. Spinoza, under the special influence of the Cartesian principle, no doubt aided the emancipation of many systematic minds, of which indeed we have proof in the multitude of refutations aroused by his audacious metaphysics; but he can not be called the founder of the negative philosophy, both because he followed Hobbes, and because the highly abstract nature of his obscure dogmatic exposition admits of no sufficiently marked social use. Bayle's labors had this last quality; but the discontented character of his partial attacks, even more than chronological considerations, marks him out as a leader of the propagation of the doctrine rather than as one of its framers; though he had undoubtedly a share in its formation. We are thus obliged to regard Hobbes as the father of the revolutionary philosophy. We shall hereafter find that he held a much higher position than this, as one of the chief precursors of the true positive polity; but he was also the author of some of the most important critical views which have been attributed to men of the succeeding century who were only the propagators of them.

Hobbes.

Its intellectual character.

In this philosophy, the anti-theological analysis is urged as far as the metaphysical spirit admits; and it therefore affords the best opportunity for contrasting the negative philosophy with the positive, with which superficial inquirers are very apt to confound it. The negative doctrine, improperly called atheism, is simply a final phase of the ancient philosophy, first theological and then more and more metaphysical, while retaining the same qualities, the same absolute spirit, and the same tendency to handle questions which sound philosophy discards, as inaccessible to human reason. It substitutes Nature for the Creator, with much the same character and office, impelling to a very similar worship; so that this supposed atheism amounts to inaugurating a goddess in the place of a god,—by those at least who regard this transient stage as a settled one. Such a transformation may effect an entire disorganization of the social system which corresponded to the theological philosophy; but it is altogether inadequate to the formation, social or intellectual, of a genuine new philosophy. The human understanding must remain subject to the theological metaphysical *régime* till the consideration of universal natural laws become prevalent: and that was impossible at the time of which I speak, from men's imperfect knowledge of those laws. The positive philosophy therefore can acknowledge no connection with the negative doctrine, further than that the negative opened a way, and established a preparation for the positive. Till positive conceptions prevail, there is perpetual danger of a recurrence to the old theological doctrine; and the negative philosophy affords little better security against this danger than deism itself. It partakes of the nature of all theological ideas, which are identical through all their transformations; and thus we may explain the seeming paradox of the affinity between the obsure systematic pantheism of the metaphysical schools which are most proud of their advanced position, and the spontaneous fetichism of primitive times. Such is the historical estimate of the intellectual character of the critical movement.

Its moral character.

Morally considered, the metaphysical philosophy presents the first rational co-ordination of the celebrated theory of self-love, improperly ascribed to the following century. The theory is an immediate consequence of the doctrine of the *I*, as before explained,—of the notion of unity in the human being, where a great multiplicity in fact exists; for the preponderance of personal inclinations in our organism is unquestionable. The laborious efforts since made to concentrate our moral nature on benevolence or justice, the centres of which are naturally weak in comparison, may have been of use as a test and exposure of the metaphysical doctrine; but they have been no corrective of the foregoing error, and therefore no resource against the injury to our moral progress that it has caused. It is right to add that the selfish theory, though speculatively appropriate to the metaphysical theory, is directly derived from theology, which makes morality consist in a care for personal salvation, to the exclusion of the disinterested affections which the positive philosophy alone can duly encourage and direct. Metaphysics has merely transferred the personal anxiety from eternal to temporal interests, without being able to rise to the conception of a morality which should not rest on personal calculation of one kind or another. The appropriate danger of the negative doctrine, in this respect, was that by its dogmatic confirmation of this view of human nature it destroyed the antagonism which went far to neutralize the mischief of the theological view,—the setting up of imaginary personal interests in happy opposition to real ones; but it must not be forgotten that the original mischief was in the religious proposal of a personal interest so engrossing that its prescribed consideration must repress, as far as our nature allows, all other affections whatever. Here again we see that the metaphysical philosophy is a protraction of the theological, in its moral as in its intellectual aspect; and the theory of self-interest is no mere accident occurring in the development of the metaphysical philosophy, but one of its primary features, transferred, under modification, from the preceding *régime*.

Its political character.

Politically regarded, the formation of the negative philosophy is marked by the dogmatic sanction it gives to that subordination of the spiritual to the temporal power which we have seen to be already established, but which was not fully accounted for till Hobbes offered his decisive discussion. I have said enough of the necessity and probable duration of this state of things to be enabled now to pass over the subject lightly, merely observing that while there was a general acquiescence in the temporal dictatorship, the action of the critical philosophy must stop at the spiritual disorganization, deferring its attacks on the temporal till the corresponding reorganization had begun. No doubt, Hobbes had such a course of things in view, though his metaphysical treatment of his subject gave him the appearance of supposing the provisional state to be a permanent one. It is inconceivable that a man of his sagacity should have supposed that he was thus framing a natural and durable state of modern society so immediately after the best thinkers had declared the inevitableness of a universal revolution. Nor is it probable that his philosophical successors, of whom Voltaire was the chief, could, however much levity was, as in his case, mingled with sagacity, have doubted that their doctrine was a transitional one. However this may be, it is easy to see that a doctrine which restricted its action to the spiritual order of ideas must have been in a favorable position, from the security which was felt by rulers as long as their temporal power was undisturbed. In regard to Hobbes, it seems to me remarkable that, notwithstanding his national predilection for aristocracy rather than royalty, he should have chosen monarchical power for the single centre of his political scheme; and this view of his has furnished to the retrograde school, which is more powerful in England than anywhere else at present, a specious pretext for avenging the peers and clergy on the progressive spirit, by representing it as an abetter of despotism, so as to impair by a welcome calumny its European reputation. My impression is that, in the first place, Hobbes was aware that the monarchical dictatorship was better adapted than the aristocratic to facilitate the necessary decay of the old system, and the development of new social elements: and that, in the second place, he was instinctively aware that his doctrine, far from being specially English, must meet with its completest reception and development among nations in which royalty was the form of political concentration: instances of insight and foresight to which I believe the sagacity of the illustrious philosopher to be fully adequate.

Its propagation.

So much for the formation of the negative doctrine. We must now proceed to observe its propagation. Hitherto, it had been restricted to a few select minds; but its final destination depended above everything on its becoming sufficiently popularized. The first observation we have to make on this new revolutionary phase relates to the change in the centre of movement, and in its permanent organs.

The work of destroying the old theological and military system had first been carried on, as we have seen, in Germany, Holland, and England. In those countries the political triumph of Protestantism had neutralized its tendency to philosophical emancipation by connecting with the conservative system the kind of organization that Protestantism would admit of. Thenceforth, all emancipation of the human mind became more repugnant to official Protestantism than to the most degenerate Catholicism itself, because it evidenced the radical insufficiency of the spiritual reformation which had cost so much. The repugnance extends beyond official Protestantism, to the least orthodox dissenting sects, which, proud of their comparative freedom, cling the more earnestly to the doctrines they have retained, and which therefore hold in especial horror such an irresistible concurrence of philosophical opinions as dispenses at once with all this laborious Protestant transition. In Catholic countries, on the other hand, where the people had any intellectual liberty left at all, the only refuge from complete mental despotism was in the negative philosophy, systematically extended. The centre of the intellectual and social movement was therefore transferred to Catholic countries, and especially to France. The whole of Christendom was concerned in the entire reformatory movement; but its purely Protestant periods were conducted by Germany, Holland, and England, in succession, while France was destined to illustrate its last revolutionary phase. With the change of the centre of philosophical movement, came a change of its organs. We may assign to this period the rise as a class of the scholars, or men of letters, who now took the place of the heads of faculties, or doctors properly so called; in the same way that the lawyers provisionally assumed the social authority before held by the judges. The change took place as a matter of necessity from the adhesion of the universities to the retrograde system, after having been the first movers in the critical direction. This kind of defection, which began in Protestant countries, soon spread to Catholic nations, where the parliaments and universities were seen, at the end of the seventeenth century, to have as much horror of intellectual freedom and as much attachment to the retrograde coalition as the official administrators of legalized Protestantism in reformed countries. Meantime, the universities were giving an education less and less doctrinal and more and more literary, and were sending forth, in every country, a great number of men who, having neither positivity enough for true scientific culture, nor a logical training for the philosophical profession, in its true sense, nor imagination to qualify them for the poetic career, and yet deciding upon an intellectual vocation of some kind, were led to form that highly equivocal class of modern European society, which have no express mental function, and are known by the names of men of letters, authors, etc. All circumstances being, in their case as in that of the lawyers, unfavorable to the generation of deep convictions,—even of such obscure metaphysical convictions as every ancient doctor had of his own,—these modern scholars could not be the agents by whom the negative philosophy should be systematically wrought out: but, when it was once founded by genuine philosophers, they were the men to direct its propagation, in a manner more active, more varied, and more effectual than could have been adapted by a more truly philosophical order of minds. Their defects were favorable to their work. Their want of profound conviction lessened the absolute character of their propositions; and their versatility enabled them to meet the existing social need of partial stimulation in various directions. Such an intellectual condition would be truly monstrous if it were regarded as permanent; but it was adapted to the requisitions of the last stage of the spiritual disorganization.

By this time the emancipation had proceeded so far that the mere existence of anti-theological discussion brought after it the certainty of the propagation of the philosophical movement, the only hinderance to which was the horror with which men were taught to regard the organs of emancipation,—a horror, which must presently give way before familiarity. The advocates of the old theology confirmed the tendency to skepticism by themselves subordinating faith to reason in their appeals on behalf of the entire body of doctrine; and from the very nature of religious conceptions, whose power results altogether from their spontaneousness, nothing can preserve them from destruction when they have once become the subject of discussion, whatever triumph they may at first obtain. Thus the spirit of controversy peculiar to monotheism, and especially to the Catholic form of it, must be historically regarded as an evidence of the continuous decline of the theological philosophy. The innumerable demonstrations of the existence of God, so ostentatiously disseminated since the twelfth century, prove that bold doubts on that subject were in existence; and the defence tended to increase them, both by the weakness of many of the extremely various arguments, and by the very decision of others, which suggested the logical sin that had been committed all along in admitting corresponding opinions, without being able to support them by such victorious proofs. Pascal seems to me to have been the only philosopher of the theological school who really understood, or at least clearly pointed out, the danger of controversial demonstrations, such as abounded in his time: and when he stated his view, the consequence was that theology was reproached with receding before reason, after having long appealed to its arbitration. This was especially true in regard to the famous arguments derived from the scheme of natural phenomena. Pascal regarded these as particularly indiscreet, though dogmatic theology derived its chief evidences thence for several centuries, little suspecting that a further study of nature would disclose the extreme imperfection of the economy which inspired a blind and absolute admiration, before it could be explored in the positive spirit.

School of Voltaire.

We thus see how the way was cleared for the propagation of the negative doctrine,—for its transmission from the pure thinkers to the authors who were to popularize it. We may discern how the title of philosopher had been lowered before it could be applied to these last, to whom the art of expression was more important than the power of thinking; but the intellectual and social need of their office assigns a place in history to the most important of their class, with Voltaire at their head,—the singularly admirable combination of secondary intellectual qualities in his mind presenting so largely the appearance of strength and genius. In its passage from the thinkers to the writers, the negative philosophy assumed a weaker character, both in accommodation to the feebler rationality of the new organs and for the sake of the universal propagation of the movement. The school of Voltaire brought the doctrine of Spinoza, Hobbes, and Bayle, to a stop at deism, properly so called, which was sufficient for the entire destruction of the religious system, while it was less alarming. It suited that school, in their logical weakness, to prolong for their own use the inconsistency of Protestantism, by which religion is destroyed in the name of the religious principle, so as to include within the movement the most timid believers. The intellectual and social mischief of their method is evident now in the encouragement thereby given to convenient hypocrisy, and by the confusion it has caused in the popular mind about the real direction of the movement, which it is supposed by many pretended thinkers, may be stopped at deism. In like manner their predecessors supposed it might be stopped at the Socinian phase, at the Calvinistic, and even at the Lutheran,—no failure having conveyed any instruction to successive sects. The absurdity reached its height when the movement of emancipation was expected to stop at the least substantial and durable of all theological states. It does not fall within my purpose to examine the methods of propagation employed by the school of Voltaire; but I may just point out that their work was less hindered than might be supposed by the negative character of their doctrine. The absence of common convictions, and the presence of as many views as there were men, were of little consequence when the work to be done was that of destroying what they all alike disbelieved. Their intellectual differences and moral and social rivalries might however have discredited their work, as they had that of Protestantism, but for Diderot's happy expedient of the Encyclopedic enterprise, which might serve as a centre for the most divergent efforts, and give some appearance of a philosophical system to the aggregate of these incoherent speculations. There is no need to dwell on the powerlessness of the conception, directed by the metaphysical spirit alone, and wholly unfit to give an idea of Bacon's great original project, either as to spirit or method. The carrying out of that project is even yet premature, being in no way related to a negative philosophy, and impracticable till a truly positive philosophy shall have obtained its due ascendency.

Such is the historical view of the most decisive and prolonged part of the philosophical movement appointed to the eighteenth century. When we consider the superficial or sophistical nature of the attacks aimed against the old system, and the weak logic and the irrational direction with which they are chargeable, we shall see that nothing but miracle could have accounted for their success, if they had not been in accordance with the needs of modern society, as it stood at the end of four centuries of change. The efforts of the destructive school, which would have exerted but little influence some centuries before, were now countenanced and sustained by eminent contemporaries of every order, whether they took any active part in them or not. The original sanction which the negative philosophy had given to the temporal dictatorship happily concealed its revolutionary tendencies from commonplace statesmen, who can estimate none but immediate material consequences; but it is impossible to suppose that the political genius of Frederick the Great was blind to the bearings of the intellectual movement. The constant protection afforded by so competent a judge to the propagation of the movement could arise only from a strong conviction of the provisional necessity of a negative phase like that of his time, in preparation for the natural organization of a rational and pacific philosophy, such as had ever been, from the time of the Roman conquest, the object of aspiration of all superior men, of all castes and conditions.

Its political action.

It only remains for me now to notice very briefly the political action of the negative philosophy,—the preparation for the great revolutionary outburst which was sure to occur whenever the spiritual disorganization should have gone so far as to turn attention upon the temporal. The new philosophical school had appealed to the intellect of men, however feebly and frivolously. The new political school appealed to the passions of men, and thence derived such strength as it obtained. I need not say that its advent and its action were inevitable. Hobbes had favored the temporal dictatorship so far as to advocate its being left intact.—provisionally, of course, and as long as there was work to do in the spiritual department; and when the critical spirit had finished the work of destruction there, it was so far exhausted, or alarmed at

School of Rousseau.

the prospect of total anarchy, that it passed on somewhat feebly to the attack on temporal institutions, and showed little firmness against serious resistance. As philosophy extended to the multitude, the philosophical class consisted of minds more and more ordinary, united to characters less and less lofty, and fully inclined to reconcile, each in his own case, the honors of an easy mental emancipation with the profit of an indulgent political approbation, according to the example set by many of their Protestant precursors. At the same time, the temporal rule was becoming more and more retrograde and corrupt, through the growing incapacity of royalty and the progressive demoralization of the aristocracy, which had abdicated its original and honorable function. In this state of things the critical philosophy would have been of less social use, as it was more urgently needed, if Rousseau had not roused men by convincing them that moral and political regeneration was the true end of the philosophical movement, which would otherwise end in mere fruitless intellectual agitation. Rousseau brought to the task only his sophisms and his passions, which closely belonged to each other. His nature was more that of the artist than the philosopher; and the work of framing the revolutionary philosophy into a political system was left to another order of minds. This had been partly done before, and some soberminded men were employed upon it now; but the audacious outbreak of Rousseau, with his great paradox, was necessary to direct social indignation upon the general vices of the old social organization, while it not the less involved the principle of all possible social disturbance by the barbarous negation of Society itself. To understand the service rendered, amidst fearful mischiefs, we must consider that political philosophy was then so imperfect that the best minds conceived of no other improvement than by means of modifications of the old system, whose very conditions of existence were extinct. Thus all chance of reorganization seemed to be thrown away, and the movement to be abortive in its last stage, when the anarchical school of Rousseau intervened, to open an issue to the great negative process which had been carried on for so long, and must now be brought to its revolutionary crisis. Such is the sad necessity which condemns social conceptions to gain ground only through the antagonism of empirical errors, till the ascendency of the positive philosophy shall have rationalized this last great order of human speculations.

One noticeable feature in this temporal application of the negative philosophy is its retrograde tendency in spiritual matters, which connected it rather with the Protestant, than with the philosophical movement, though it took its origin from the latter. In the philosophical school, systematic deism was merely a provisional concession, preparatory to entire theological emancipation; whereas, in the political school, deism was the basis of the social Utopia, and the only security against total anarchy. The growing tendency of this natural disposition was to bring back the school to Socinianism, or even to Calvinism, in its strict sense, in proportion to the sense of the social inanity of a religion without a worship and a priesthood. Thus we see how the two chief schools of the last century were led by their respective opposite instincts to regard deism as a temporary station, whence the one may go forward and the other backward, amidst the ruin of the old religious system; and here we find the explanation of the different impression made by the two schools on the sacerdotal instinct of our time, notwithstanding the apparent conformity of their theological dogmas.

The Economists.

The political school of the negative doctrine is usually supposed to be represented by Rousseau; but we must not overlook the participation in it of the political sect of the Economists, who bore a large share in the disorganization of the ancient social system. Without repeating what I have said before, or anticipating what I shall have to say in the next chapter, I must just observe here that the revolutionary action of the Economists consisted in the proof that they offered to rulers themselves that governments can not direct industrial progress,—an all-important point, because, military activity having declined, governments were thus deprived of their chief temporal prerogative, and, with it, of the last habitual pretext for war, which had by that time become essentially commercial in character. Notwithstanding its absurdities and exaggerations, this school rendered, in this way, unquestionable services to the task of the last century. Its chief influence is attributable to the work of Adam Smith; and it was the offspring of Protestantism, through the industrial superiority of Protestant nations; but its chief development took place, together with the rest of the negative philosophy, in France. It is curious that the first professorships of this pretended science were established in Spain, and in the least advanced parts of Italy; so curiously were its revolutionary origin and tendency concealed under special forms which made it acceptable to the existing powers, which it in fact regarded only as a useful administrative instrumentality. Yet it sanctioned the spirit of individualism and the state of no-government: and some of its professors deduce from it the superfluousness of all regular moral instruction, and all official encouragement of science and the fine arts; and, as I before remarked, the latest attacks on the institution of property itself have arisen out of the metaphysics of political economy,—now that its proper office is accomplished, and that it tends, like other parts of the negative philosophy, to the anarchy which succeeds.

Attendant evils.

The intellectual and moral evils attendant on this phase of the negative philosophy will come under consideration hereafter. Here I need merely notify what they were, for the sake of historical completeness. The intellectual guides of the time were wanting in depth of conviction, and accordingly in rational consistency. The most important and difficult questions were delivered over to the minds the least qualified to treat of them; the social movement was in the hands of sophists and orators, and the passions were appealed to to settle difficulties which required the most careful intellectual management. The Catholic system became the subject of an undue hatred; and the Protestants longed to restore the early Christian times, and others, the polytheistic system,—a curious evidence of the last desire being an actual series of attempts to revive the reputation of Julian the Apostate. Again, there was a reproduction of the old Greek notion of a kind of metaphysical theocracy, under the form, in Protestant minds, of a reign of Saints, and in others, of a reign of Sages. There was, again, a decided aggravation of the tendency to set practice above theory,—to prefer immediate expedients to general principles, and to refer all social difficulties to temporal institutions for their cure; and hence arbitrary regulations, which were dignified with the name of laws, encroached upon the domain of morals and opinions. Such were the intellectual errors and extravagances of the time, in some of which the philosophical, and in others the political, school was most deeply involved, while neither school was irreproachable in regard to any one error. The moral errors are obvious enough. All the ancient bases of morality, public and private, were destroyed, and principles of conduct were delivered over to the estimate of individual consciences, which were but too apt to involve moral ideas in their hatred of the corresponding theological conceptions. Wise as were the moral prepossessions imparted by Catholicism, they could not withstand the dissolving action of such metaphysical discussion as that of the last century; and that we possess any morality at all beyond the simplest rules applicable to the most obvious positions, and comprehensible by the rudest minds, is owing to the natural instinct of morality in Man, and the increasing influence of modern civilization. Between the moral impotence of a negative doctrine and the active vitiating influence of a sophistical doctrine, the philosophical schools of the last century exhibited a moral deterioration very like that of Epicurus, which indeed it was the fashion of the time to extol. We can see how the deistical movement developed the moral evils which grew out of the Protestant movement, by urging to its ultimate limit the spiritual disorganization which was its universal principle. In such a result we see the proof of the temporary character of this pretended philosophy, formed as it was to destroy, while it was utterly unable to organize even the simplest human relations; and the more it triumphed in its political direction, the more conspicuous was its organic imbecility. Looking at the two philosophies, and seeing how the theological could not preserve the morality that the metaphysical destroyed, and how the process was hastened by the old morality being disgraced by the intellectual discredit of theology, we can not but see that the only resource is in the positive philosophy, which alone can satisfy the needs at once of order and of progress, in which the two former philosophies, taking them under their respective charge, have, when it became necessary to unite them, signally failed.

We have now contemplated the dissolution o^f the old system under the action of the revolutionary movement. In the next chapter we shall see how the elements of a new system had been forming and silently arising in the midst of the destruction; and we must endeavor to form that estimate of these materials of social reorganization which has hitherto been impracticable, for want of the doctrine which should guide the process, and to which we must look for the full termination of the transition stage, which was virtually fulfilled in the eighteenth century.

CHAPTER XI.

RISE OF THE ELEMENTS OF THE POSITIVE STATE.—PREPARATION FOR SOCIAL REORGANIZATION.

We have finished the irksome task of observing the process of dissolution of the old system of society during the last five centuries; and we may now turn to the pleasanter consideration of the reorganizing movement which was going on at the same time.

Date of modern history.

In fixing the date of the beginning of the new social formation, we must remember that there is an interval between the generation of new social classes and the first manifestation of their tendencies. Considered in this way, it is the opening of the fourteenth century that we must fix upon as the time when the organic industry of modern society began to assume a characteristic quality. All the chief tokens of civilization indeed concur in marking that era as the true origin of modern history. The industrial expansion was then signalized by the universal legal admission of communities as general and permanent elements of the political system, not only in Italy, where it had happened some time before, but throughout Western Europe, where the event was sanctioned by various titles in England, France, Germany, and Spain; and the fact is marked and confirmed by the vast insurrections which, in almost every country, and especially in France and England, testified, during the second half of the century, to the nascent force of the laboring classes against the powers which were, in the respective cases, specially opposed to them. At the same period the great institution of paid armies was established in Italy; and they, marking a phase of industrial life among modern peoples, are as important in the organic as in the critical connection. Such innovations as the use of the compass and of firearms coincide with other tokens of commercial activity. And the same impulsion is traceable in the department of the arts, which we can hardly carry back, in their modern aspect, further than Dante and Petrarch in poetry, and the works of their time in painting and music. The scientific movement is somewhat less evident; but this was the time when natural philosophy became a special study, under forms corresponding with prevailing opinions, as we see by the new interest excited by astronomy in the intellectual centres of Western Europe, by chemical researches, and even by the first sound anatomical observations that had ever been regularly instituted. The rise of philosophy, though the latest, and mixed up with the metaphysical spirit and the beginning of scholasticism, indicated the approach of a radical renovation, one symptom of which was the direction taken at that time by the controversy of the Realists and the Nominalists. From all the four points of view it thus appears that the beginning of the fourteenth century is the date of the first development of modern civilization, as far as we may venture to assign dates to sociological processes, which are too gradual to have any natural connection with special dates, such as we introduce as aids to order of thought and precision of memory.

Rise of new elements.

The development of new social elements was coincident with the decay of the old ones in this way. Their early growth was both repressed and concealed under the contemptuous protection of the preponderant powers of the time, till those powers entered into mutual conflict; then the new elements, being necessarily called in as auxiliaries, could not but aid by their mere action the disorganization of which the conflict was a sign. To the same end, as the Catholic and feudal system was transient in its nature, its decline must begin from the moment of its highest splendor; for, its provisional office being fulfilled, its elements immediately began to lose at once the aim of their activity and the restraint which had curbed their mutual antipathy. From that precise moment the germs of the new system began to expand. When aggressive warfare was over, the human energy which was set free resorted to industrial interests for occupation; and when the monotheistic philosophy had obtained all the political ascendency it could ever have, the highest minds, finding no more theological development to be looked for, obtained a worthy scope in a scientific or artistic career. Thus we see that there was nothing accidental or empirical in the coincidence of the rise of the new order of things with the decay of the old, but rather a precise accordance between the principles and the facts of the case.

As to the order which we should assign to the four kinds of development,—it is determined by the great law of the priority of the more general and simple over the more special and complex,—though the working of the law may not be recognised till it is revealed by distance of time. This law is not confined to the coordination of speculative conceptions, but extends to all positive modes of human activity, practical and individual, as well as theoretical and collective; and its final customary application will be in social classification, the character of which will be determined by the whole of its deductions. We shall see this fully in the next chapter,—and I mention it here only because I have to arrange my historical material by means of the principle.

Philosophical order of employments.

The way in which it is to be applied, amidst the distracting speciality of the multitude of human occupations, is by drawing out a vast line comprehending all those occupations, from the most insignificant material acts to the sublimest speculations, æsthetic, scientific, or philosophical, in an ascending succession of generality and abstractness, in a normal view of their character; and therefore in a descending series of professions, according to the increasing complexity of their immediate purpose, and the more direct utility of their daily operations. Regarded as a whole, this vast series presents in its higher divisions a more eminent and extended relation, but one less complete, direct, and certain, so that it in fact often fails; whereas the lower divisions compensate for their inferior and restricted nature by the plenitude, promptness, and clearness of their unquestionable services. Individually compared, these degrees should manifest as they ascend a more and more marked preponderance of the noble faculties which most distinguish humanity; and the corresponding social labors will exhibit a more complete concentration and closer connection in proportion as we ascend to works which are, on account of their difficulty, accessible to a smaller number of co-operators, while they need a smaller variety of organs, according to the more extended scope of their respective action; whence results a more vast but less intense development of the universal sociality which, on the contrary, in the descending hierarchy, diminishes more and more, till it is restricted almost within the limits of domestic life, where, in truth, it is most valuable and best relished.

Classification.

This series is like the animal hierarchy (of which it is in fact a kind of special prolongation), in admitting and even requiring, in the midst of its continuity, some rational divisions, founded on the affinities which occasion certain modes of activity. Of those divisions, the first and most important results from the distinction between the practical and the speculative life, which we have been studying under the names of the temporal and the spiritual order. We need not subdivide the first of these, which we may call, in a general way, the action of Man upon nature: but the other, the speculative life, must be divided into two,—æsthetic and scientific speculation. And thus we have that part of the scale appropriate to modern civilization divided into three great orders;—the Industrial or practical; the Æsthetic or poetic; and the Scientific or philosophical,—of which this is the natural order. All are indispensable in their several ways: they represent universal, though not equally pressing needs; and aptitudes also universal, though unequally marked. They correspond to the three several aspects under which every subject may be positively regarded,—as *good* or beneficial, as *beautiful*, and as *true*. They are regarded in this ascending order by commonplace minds, in which the affective life prevails largely over the intellectual; whereas the reverse order is the rational one, and that which gains upon the other in proportion as the intellect assumes a larger share in the human evolution:—all which is consistent with what we have seen to be the result of our cerebral organization, which compels men in general to think most of practical utility, and next of ideal perfection; while very few are qualified for the persevering search after abstract truth. Whichever way we enter upon the study of the classification of human pursuits, I am convinced that we shall find the æsthetic element always intermediate between the industrial and the scientific, partaking of the nature of both, without however preventing their having direct relations with each other. Such is the series which furnishes the only rational basis for a statical, and therefore for a dynamical analysis of modern civilization. But there is a further subdivision which, though merely provisional, it is necessary to notice, because, however certain to disappear, its duration is no less than from the beginning of the fourteenth century to the future complete establishment of the positive philosophy. I refer to the distinction between science and philosophy, which, it may have been observed, I have just spoken of as one. They are radically one: but at present our science is not so philosophical, nor our philosophy so scientific, as to permit their being thoroughly united in our view; and for purposes of historical exposition of the last five centuries, we must make a fourth element out of this subdivision. In fact, we must submit to a final protraction of that old Greek error of twenty centuries ago, of separating natural from moral philosophy; an error which has been sustained and rendered conspicuous during the last five centuries by the expansion of natural philosophy, properly so called, and consecutive transformations of moral philosophy. I proceed, then, on the supposition of there being four classes of social elements,—the industrial, the æsthetic, the scientific, and the philosophical,—striving to keep before my own mind and the reader's the merely provisional character of the last division.

Order of succession.

It will be at once admitted that while all the four elements coexist permanently, they are, from their nature, developed at unequal rates; and also that the same law which regulates their respective positions in the scale, decides the succession of their development; and again, that the rise of any one of them impels that of the rest. I need not enlarge again on the reciprocal influence, for direction and excitement, of the scientific evolution and the industrial; and the great social consequences of this connection will appear hereafter. But we are much less aware of the equally certain connection between the æsthetic and the two extreme evolutions. The positive theory of human nature shows us that the cultivation of art naturally succeeds that of industry, and prepares for science and philosophy; and when the progression is, by an exceptional course, in an inverse direction, it is certain, though not so obvious, that scientific activity urges to a certain æsthetic activity, if only for the sake of mental relaxation ; and that the practice of art is again favorable to industry. And thus it appears that the mutual action of these elements is as unquestionable as their respective position ; that is, their dynamical as their statical arrangement.

In regard to the historical application of this arrangement, and bearing in mind that it is not the origin of any element that we are here concerned with, but its historical appearance,—it seems unquestionable that we must ascend the scale, noticing first the industrial aspect of modern civilization, and rising to the philosophical. It is certainly the industrial quality of modern societies which offers their first great contrast with those of antiquity. The industrial element is new ; and the others, though far more powerful in recent than in ancient times, had then a very conspicuous existence. After the emancipation of the primitive laborers, the most advanced societies were mainly distinguished by the gradual preponderance of the industrial over the military life ; and it was thus the source of their other essential attributes, and the mainspring of their method of social training. The intellectual awakening consequent on this practical activity, and the relative ease spread through society, naturally occasioned a more disinterested extension of the fine arts, which had never been so widely propagated, in their three chief forms, during the polytheistic period. In another view, we see that the improvement in the industrial arts has raised them to a kind of æsthetic quality,—especially in the case of the geometrical arts. Again, the industrial evolution was necessary to impart to the scientific spirit of modern times the thorough positivity which characterizes it, and which has extended from it to the philosophical spirit. So that, on all accounts, we see that the ascending direction is that in which human progression is to be traced ; and that the descending one, which alone is perfectly rational, is impracticable till social science has advanced much further than at present.

Such doubt as there is, relates to the order of the æsthetic and scientific evolutions. Though their order is usually what I have now made it, it may be objected that in Germany, the development of science clearly preceded that of art. But, for this single instance exceptional reasons might be assigned, if it were within my province ; and it must be our rule to study the civilization, not of any one nation, however important, but of the whole portion of mankind involved in the movement of western Europe ; that is (specifying the nations once for all) Italy, France, England, Germany, and Spain. These five great nations may be regarded as having constituted, after the first half of the Middle Ages, one single people, immensely different in various respects, but bound up together under the Catholic and feudal systems, and undergoing together all the subsequent changes which the system brought after it. This being our field of observation, we shall decide that the scientific development was certainly posterior to the æsthetic. This is remarkably clear in regard to Italy, which led the rest of the world in the most important particulars of civilization, and in which we observe the spirit of Art gradually growing up on the traces of industry, and preparing the way for science and philosophy, through its beneficent property of awakening speculation in even the most ordinary minds. As the descending order, however, was the natural one in the infancy of society, when all civilization issued from the theocratic principle; and as it will again be the natural one when society shall be philosophically organized, it is now the natural order in the interior of each of the divisions in the scale of human pursuits. In each, we shall find the course of progression to be from the more general to the more special,—from the abstract to the concrete. And thus, for five centuries past, the ascending and descending order of progression has gone forward,—the one for the general human advancement, and the other for the three special modes of advancement. The actual case represents the natural course of an ideal society, whose early stages could be preserved from theology and war: and it is exhibited to us now in the more restricted instance of individual education,—in as far, at least, as it is spontaneous,—in which, æsthetic follows industrial activity, and prepares for scientific and philosophical action.

I have thus laid down the date and order of succession of modern civilization; and we may proceed to survey its four great departments,—beginning with the industrial evolution.

THE INDUSTRIAL MOVEMENT.

It appears to me that when serfage succeeded to slavery, the change constituted a kind of direct incorporation, in the earliest degree, of the agricultural population with society in general, to which that population had been hitherto a sort of domestic animals. From that moment, the cultivator, attached to the land, which was then the most stable of possessions, began to acquire, even in his poor and precarious condition, something like social right;—if no more, the most elementary of all,—that of forming a family, properly so called, which was now, for the first time, sanctioned by his new position. This amelioration, from which all other civil emancipation proceeded, seems to assign the country as the first seat of popular enfranchisement; and this great social phenomenon connects itself naturally with the instinctive predilection of feudal chiefs for an agricultural life, with its precious independence, and with the fine spectacle, so common in the Middle Ages, of the holy hands of monks being extended to labors always before regarded as degrading. Thus, the condition of the country appears to have been at that time less miserable than that of the towns, except in the case of some few centres, which were of great importance as points of support for future efforts. There can be no doubt of the tendency of the medieval system to distribute the population uniformly, even in the most unfavorable localities, by an interior influence, analogous to the exterior, which, interdicting invasion, established settled populations in the most barren countries of Europe. We must unquestionably refer to this period the systems of great public works undertaken to improve places of abode, whose inconveniences could not longer be escaped from by a hostile emigration; for it was now that the miraculous existence of Venice, and yet more, of Holland, began to become possible, by means of obstinate and thoroughly-organized efforts, beside which the most laborious of ancient operations appear but secondary affairs. Here then was a beginning of popular emancipation, which must necessarily precede and prepare for a total abolition of personal slavery of every kind. The next period, of three centuries, from the beginning of the eighth to that of the eleventh, was the season of a final preparation for the industrial life, which must succeed to the abolition of popular servitude. Of the two great objects of the institution of personal bondage, one had been accomplished under the period of conquest;—the leaving scope to military activity for the accomplishment of its ends. The other,—the providing industrial training to the mass of men, to whose nature toil was repugnant,—was fulfilled when there was a cessation of the influx of new slaves, and when, under the feudal system, the chiefs were dispersed among submissive populations, and their inferiors were initiated into industrial life by a regular organization. A starting-point was fixed for each serf, whence he might proceed, by extremely slow degrees, toward the individual independence,—the principle of which was universally sanctioned by Catholic morality. The conditions of ransom, usually very moderate, affixed to such liberation, besides regulating a just and useful indemnification, furnished a significant safeguard of such progress, by showing that the freedman was capable of such moderation and foresight as rendered him fit for self-government. For this indispensable preparation the slave of a more ancient time was unfit, while the serf of the Middle Ages was more and more disposed to it, both in town and country, by the influences of the corresponding social state.

Such was the temporal influence of the period immediately preceding personal emancipation. The spiritual influence is obvious enough. The serfs had the same religion with their superiors, and the same fundamental education which was derived from it; and not only did religion afford them rights by prescribing reciprocal duties, but it steadily proclaimed voluntary emancipation to be a Christian duty, whenever the laboring class showed its inclination and its fitness for liberty. The famous bull of Alexander III., on the general abolition of slavery in Christendom, was merely a systematic sanction, and a rather late one, of a custom which had been extending for some centuries. From the sixth century, the temporal chiefs, who were under the fresh influences of Catholicism, had conferred personal freedom, sometimes on the inhabitants of a considerable district; and the practice spread so rapidly that history relates some few cases in which the boon came too early for the needs and the desires of the recipients. The influence which thus wrought, was not that of moral doctrine alone. The morality was enforced by the persevering action of a priesthood which was opposed to the institution of caste, and open to be recruited from every social class, and which relied mainly for the permanence of its organization on the laboring classes, whose rise it therefore constantly favored.

I have said that at the beginning of the change, the condition of the agricultural laborers was less burdensome than that of the artificers in the towns: but the emancipation proceeded faster in the towns than in the country. The diffusion of the agricultural population, and the more empirical nature of their daily employment, must have retarded the tendency to entire emancipation, and the fitness both to obtain and to use it; the residence of their chiefs in the midst of them would generally relax the desire, and increase the difficulty of enfranchisement; and the spiritual influence itself would be at its weakest in that case. Whereas, the town populations which had obtained, as organized communities, full industrial development, reacted upon the country; so that during the twelfth, and yet more the thirteenth century, the cultivators gradually obtained freedom in almost all important parts of Western Europe, as Adam Smith and Hume have shown us in expositions which are luminous, in spite of the injurious influence of the philosophy of their day. If we look at the process from the other end, we shall see why personal liberty must have been first obtained in the cities and towns. The servitude was more onerous there, from the absence of the master, who delivered over the multitude to the despotism of his agent. The wish for liberation, which must thence arise, was aided by the concentration of numbers, which made its fulfilment the easier. A far more important reason was that the labor of the townsmen, whether manufacturing or commercial, was of a more abstract and indirect nature, requiring a more special training than that of tilling the soil: it required a smaller number of agents, a more easy and habitual concert, and a greater freedom of operative action; a concurrence of qualities which easily explains the earlier emancipation of the manufacturers and traders. If my space permitted further analysis, I could easily show that the traders, concerned in the more abstract and indirect employment, were enfranchised before the manufacturers; and that the first class of traders who obtained their freedom were those who were concerned in the most abstract and indirect kind of commerce —that of money exchanges. The money-changers rose to be opulent bankers, the first of whom were usually Jews; and, as Jews, outside of a servitude which would have incorporated them with Christians, however otherwise oppressed. But they were systematically encouraged by the polity of the time, and always more free in Rome than in any other part of Christendom. In precocious Italy, the most special precocity was in the commercial genius which made Venice the wonder of the civilized world; and Genoa and Pisa, even before Florence. The same kind of importance distinguished the commercial elements of the Hanseatic League and cities of Flanders: and the nascent industrial prosperity of France and England was attributable to the establishments, in the thirteenth century, of the Italian and Hanseatic traders, which, from being mere counting-houses, became magazines, and were at length transformed into great centres of manufacture.

Birth of political liberty.

In inquiries of a different nature from this, it is usual to present the phase of political struggle as beginning with the enfranchisement of communities, without inquiring whether that enfranchisement had any other origin than accident, or some evidently insufficient cause. I must avoid any such fatal break in the history of society by pointing out how and when any collective liberty was acquired by communities. The interval between the obtaining of personal and collective liberty was short; for the latter was not only a necessary consequence of the former, because without it there could be no great industrial progress, but it was obtained more and more rapidly as the forces of opposition relaxed before growing success. Independence was obtained more easily than personal liberty, because it was known that the one could not long be withheld when the other was granted; and it can scarcely be said that the interval between the completion of the first movement and the beginning of the other was longer than the earlier half of the eleventh century. The feudal organism, dispersive in its nature, and foreseeing nothing of the future struggles which must ensue, made no difficulty of admitting industrial communities among the elements of which it was composed. The Catholic organism was even more favorable to such a progression, not only from Christian principle, but from the support that the sacerdotal polity expected to derive from the elevation of the new classes, whose mental emancipation was as yet dreamed of by nobody.

With regard to the dates,—the entire movement of personal emancipation, from the end of slavery to the end of serfage, coincided with that of defensive warfare, beginning with Charles Martel, and ending with the establishment of the Normans in the West: and the next phase,—that of the establishment of industrial communities, with its resulting operation on rural enfranchisement,—was coincident with the crusading struggle against the invasion of Mussulman monotheism. As for the area, it was precisely that of the Catholic and feudal system,—the movement taking place universally within the limits of that system, and nowhere outside of it, either under the Mohammedan or the Byzantine monotheism; and it was easy and rapid above all in Italy, where the Catholic and feudal organism manifested its greatest vigor. The Catholic influence showed itself in the permanent anxiety of the popes to accommodate the differences which impeded the nascent coalition of the industrial communities, whose polity was for a long time habitually directed by the religious orders. And the feudal influence was seen at the western limit of the area, where the Hanse Towns arose under the protection of the Empire, corresponding with the Italian cities by the natural intervention of the Flemish towns, and completing the general constitution of the great industrial movement of the Middle Ages, which spread, by the Mediterranean basin, to the furthest parts of the East, and by the Northern seas to the northern extremities of Europe; an area of European relations far more vast than the Roman dominion could boast in its proudest days. It is for philosophical minds to feel how great is our obligation to the *régime* which gave its first impulse to our existing civilization, however incompatible with further human progress that system may have become.

Our next step must be to ascertain the natural characteristics of this new moving power, and to point out the vices which have equally distinguished it, up to this time.

Characteristics of the Industrial movement.

There can be no doubt that the change we have been examining constitutes the greatest temporal revolution ever experienced by mankind, since its direct effect was to change irrevocably the natural mode of existence. If the Greek philosophers of twelve centuries before had been told that slavery would be abolished, and that the free men of a great and powerful population would subject themselves to labors then considered servile, the boldest and most generous thinkers would have called out upon a Utopia so absurd and utterly baseless: for the world was yet too young for men to have learned that, in matters of social change, spontaneous and gradual evolutions always end in far transcending the most audacious original speculation. By this vast regeneration, the race closed its preliminary period, and entered upon its definitive state, in regard to practical life, which was thenceforth brought into agreement with our general nature; for a life of labor is, when become habitual, the fittest to develop all our chief dispositions of every kind, as well as to stimulate to co-operation; whereas military life exercises the faculties very partially, and makes the activity of some depend on the repression of others

Personal effect.

By the highest and truest test that we can apply,—the gradual ascendency of the faculties of humanity over those of animality,—the substitution of the industrial for the military life has raised, by one degree, the primitive type of social Man. The use of the understanding in practical matters is more marked in the industrial life of the moderns than in the military life of the ancients, if we compare two organisms of the same rank in the two situations, and discard all reference to modern military life, which requires a special mechanical character in the common soldier. Industrial pursuit is suitable to the intellectual mediocrity of the vast majority of the race, which can best deal with clear, concrete, limited questions, requiring steady but easy attention, admitting of a direct or proximate solution, relating to the practical interests of civilized life, and bringing after them a pretty certain reward of ease and independence, in return for sense and industry. The next test,—the influence of the social on the personal instinct,—shows us that industrial life favors a universal goodwill, because every man's daily toil may be regarded as concerning others quite as much as himself; whereas the military life encouraged the most malignant passions, in the midst of the noblest devotedness. If it is objected that minds are restricted, and that selfishness is encouraged, by such extreme division of labor and care for private interest as we every day witness, the explanation is that the industrial expansion has thus far been merely spontaneous, not having been systemized by rational principles, as it is destined to be. Till it is organized to the same extent as the military system was in its best days, it would be unjust to compare the social qualities of the two. If war, with its barbarous origin and temper, could be organized into an instrument of social service, there is every reason to hope that the vices which are involved in industrial pursuit may be, in like manner, neutralized by a similar method. In the absence of such discipline, the industrial life has unquestionably developed new intellectual and sympathetic power in the very lowest class of the population, from the Middle Ages to this day.

Domestic effect

The influence of the change on domestic life has been vast; for it opened that mode of existence for the first time to the most numerous class,—there being nothing in the condition of slaves or serfs which is worthy the name of family life. Even free men were not before aware of the destination of mankind at large for domestic life, and were perpetually drawn from it by the tumultuous emotions of the city and the battle-field. Again, the two great family relations were improved by the change which brought the occupations, and therefore the manners, of the two sexes into more resemblance, and which lessened the absolute dependence of children upon their parents. Much of the benefit is lost by the absence of organization: but the industrial and the Catholic system worked well together in favor of domestic morality. And if there seemed reason to apprehend that the subordination of the female sex would suffer by the independence obtainable by women under the industrial system, the danger was fully compensated for by men having engrossed various occupations that before belonged to women, and thus consigned the feebler sex to that domestic destination to which alone it is completely adapted.

Social effect.

Proceeding to the social aspect of the change, we see that the industrial movement abolished the system of Caste by setting up against the ancient superiority of birth that of wealth acquired by industry. What the Catholic system had done in suppressing the sacerdotal caste, and founding spiritual rank on capacity, the industrial movement realized in its own way, in regard to even the lowest social functions. The tendency to inheritance of occupation gave way in the lower ranks before the instinct of general improvement which had caused the enfranchisement itself; and in the higher ranks, before the well-known impossibility of preserving great commercial and manufacturing fortunes in the same families. These causes, combined with the increasingly special character of employments favored by merely temporal methods, a closer agreement between aptitudes and destination: and at the same time, the natural connection between private and public interest was directly improved by that marvellous instinctive social economy by which each industrial member is constantly employed in devising and carrying out new methods of serving the community,—every private operation assuming the character of a public function, and the broad old division between the two becoming indistinguishable. Much of this action arose, certainly, from the self-interest and cunning proper to emancipated slaves: but the love of gain is surely preferable to the love of pillage which preceded it. Much of the imperfection of the industrial system is due to the absence of organization; and the rest to the imperfection of human nature; but the vices which may be remedied and those which can not are a good exchange for those of a period of slavery and war. As for the industrial influence, as it affected social transactions,—it substituted the principle of reconciliation of interests for the spirit, first hostile and then litigious, which had prevailed before. During the medieval period, when industrial communities legislated independently, before the formations of the greater polities, there were commercial tribunals and regulations which do great honor to the Hanseatic merchants, whose jurisdiction contrasts very favorably with others of that age. Even such despotic action as there was in the system was an improvement. Considering the natural indolence of the human constitution, it could hardly have been foreseen that the prevailing desire of the majority of free men would be for permanent labor; but when this happened, the granting or refusal of work became the common basis of social discipline, preventive and coercive, and the great substitute for direct force. However this new power may need regulation, there can be no doubt of its superiority to the military principle of discipline, in which pain and death were the sanction of all subordination. The industrial principle of discipline is less oppressive, more indirect, and therefore avoidable; and it leaves room for a clearer and more active sense of the reciprocal need of co-operation, and for more conciliating manners. The international operation of the industrial spirit is as remarkable as any part of its action. All causes of international antipathy, even the religious, have succumbed to it. Deficient as it is in organization, the most powerful retrograde system has receded before it; even the national egotism of England having been unable to restrain the perpetual extension of the pacific dispositions of commerce toward rival nations. Whatever may have been the original effect of the military spirit in extending human association, it not only had been completely exhausted, but it could never have been comparable to the industrial spirit in admitting of the total assimilation of the human race.

This estimate of the qualities of the industrial system was required by the vastness of the change which it introduced into social life. It brings us up to the assigned date, at the opening of the fourteenth century, whence, having settled the relation of the industrial period to more ancient institutions, we may proceed with our historical analysis of its development. In what remains for me to say, it will be understood that, for reasons already sufficiently explained, I speak of the concentrated industry of towns.

The policy of the laboring classes, from their first emancipation onward, has been, generally speaking, distinguished by two characteristics,—speciality, with liberty for its condition; that is, such new powers as have been sought have been desired for industrial purposes; and political efforts have had industrial liberty for their object.

Industrial policy.

It was as a safeguard of such elementary freedom that the primitive independence of the town populations was so important, in the midst of many errors: and this was the destination of the guilds which incorporated the members of each craft, and protected individual industry at first, however they might oppress it at last. By preventing capricious changes of occupation also, they helped the formation of industrial manners, and exerted a moral influence which was of high importance in so new a mode of life. This is the true origin of the characteristic passion of modern society for universal and permanent liberty, as a natural consequence of personal emancipation, and a condition of every man's proper activity. In as far as it rested on an industrial basis, their policy was secure: and we must therefore depart from common opinion so far as to think that the preceding political repression, under the theological and military system, was fortunate for the new element, as long as it was not fatal to it. An evidence of this is afforded by the misfortunes of communities in which the repression ceased too soon, and retrograde influences were mixed up with the progressive, in the form of political ambition. The Italian cities, which had been foremost in political liberty, paid for the privilege by fatal mutual animosities and internal quarrels, till their turbulent independence issued everywhere in the supremacy of a local family, —first feudal in Lombardy, and afterward industrial in Tuscany. But Venice was saved from the fate of her neighbors: and the Hanse Towns, by their political liberty being restricted till their commerce was established, escaped all fruitless disturbances of the industrial life, which grew up within them as prosperously as in the midst of the most powerful feudal organizations,—like those of England and France. And thus the action of the corresponding *régime*, which appeared to be so much pure hinderance to the new element, was in fact one of the main conditions of its development.

Relation to Catholicism.

The relation of the industrial element to the corresponding powers, and especially the spiritual, may be easily anticipated. It was warmly welcomed by Catholicism, both on account of its conformity with the general spirit of the system, and as an ally of the ecclesiastical power in its political antagonism. On the other hand, there were discordances from the theological character of the philosophy of the time. Besides the anti-theological character of industry, as action by Man on the external world, a more direct discrepancy arose between the ardor of industrial activity and the due Christian care for personal salvation. The absolute character of theological doctrine prevented its accommodation to circumstances unforeseen at the time of its formation; and it could only interfere by vague and imperfect precepts, which were often incompatible with the conditions of industrial life. One instance of this is the denunciation of usury by the clergy. After being of some use in restraining cupidity, this prohibition became a hinderance to indispensable transactions, and indirectly stimulated extortion. To this day the clergy have been unable, after all their laborious theological speculation, to agree upon any theory about the interest of money lent; and thus has religious morality, devoid of popular good sense, been for ages an unsuccessful adversary of industry, with popular wisdom for its ally. The opposition thus arising explains why the laboring classes, though receiving with respect the intervention of the clergy in their general affairs, always turned with decided preference to the temporal power, which never seriously interfered with their activity. Before the time came for social rivalship between the aristocracy of birth and that of wealth, the industrial class regarded the nobility as (by their luxury) the great cause of production, and, by the superiority of their moral training, the best types of individual perfection. In both these ways feudal manners have certainly been constantly favorable to industry. To this day new inventions are proposed even too much with a view to the rich few rather than the great multitude of consumers; and social superiority and hereditary wealth have, on the whole, encouraged a largeness of views and a generosity of sentiment among the feudal class which would have been incompatible with the special pre-occupations of industrial pursuit, and which have ever been looked up to as matters of imitation by the laboring classes. There is every reason to suppose that the possession of a great patrimonial fortune will always be a ground of social influence; and it is difficult to overrate its importance in the times nearest to the origin of industrial pursuit. The attachment to royalty must have been more eminent than that to aristocracy; and while industry was looking up to the local temporal authority, whatever might be its form, it usually turned with a higher preference to the central element; for royalty offered all the advantages of aristocracy, without the same danger from collision; the only set-off being the payment of taxes, which could not have appeared burdensome to nations who were yet in the fresh enjoyment of this power of commuting their social difficulties. Thus the industrial populations in general were specially attached to royalty, at the very time that in some exceptional cases—in England, for one—they were leagued with the nobility against royalty, and, by that permanent tendency, retarding the natural decline of the royal power.

Relation to the temporal authority.

Administration.

As for the management of the industrial polity, it at first fell into the hands of the clergy or nobles, whose interests were bound up with those of the industrial communities; and chief among them we observe the recent religious orders, and then some great feudal families, who acquiesced in the new state of things, and were content to establish their greatness on an alliance with industry. But a special class was soon required for the conduct of the new polity; and that class was the Legists, whom we have seen before to be occupied in taking the old system to pieces, while we here find them helping to construct the new one. However deplorable their influence has since been found, from its undue protraction, we must not forget that it was indispensable, at a time when the Legists were the only class who could confer with the ancient powers about industrial affairs, whose interests were bound up with those of town populations, and whose intervention set the working classes free to follow their own occupations, without disturbance from political agitations which could be carried on by deputy.

Three periods.

The reader will remember that the five centuries of the revolutionary period were, in the last chapter, divided into three portions: that the period of spontaneous decay of the ancient system extended to the end of the fifteenth century; and that the subsequent period of systematic destruction was divided into two,—the Protestant period of the negative philosophy, extending to about the middle of the seventeenth century, and the Deistical period, occupying the rest of the time. The same division precisely suits the analysis of industrial development; and I therefore repeat it, impressed with the coincidence of the periods of critical and organic progression. It was perfectly natural that the two movements should proceed together. The decaying powers gave out some of their strength to the rising ones, both through the sympathy which the Catholic and feudal spirit entertained for nascent industry, and for the political reasons which urged the temporal power to secure the support of the new body of social forces; while, on the other hand, the extension and consolidation of industry helped the decay of the old system by undermining the customary subordination of the classes which were learning independence. From this time the great cities, the centres of civilization, became united in common interests, and drew into their influence the more diffused populations of which they thus became the protectors; and London, Amsterdam, and other great commercial cities, and even Paris, assumed, on other than political grounds, an influence very unlike that proud spirit of universal domination exhibited of old by the few strongholds of military activity. Then arose paid armies, as an expedient at first, and soon as a permanent institution. The innovation had an industrial origin, beginning at Venice, at the opening of the fourteenth century, and then extending by way of Florence to other states, and over all Western Europe, testifying to the antipathy of the new populations for military life, which was henceforth consigned to a special minority, ever decreasing in its proportion to the rest of

Paid armies.

Public credit.

society, though usually more numerous in some instances of modern warfare. The decline of the old system was hastened by the people being thus withdrawn from the military chiefs, and placed under industrial leaders; and again, by the discrediting of the charities administered by the clergy, when better resources against want were opened by industry. These advantages were the greater from the workmen being few, and highly-skilled workmen extremely few, in comparison with the present time, and therefore individually more powerful. We see in this period even the first indications of public credit, which is usually supposed to be of much later origin. I can not hesitate in referring it to the efforts of Florence and Venice about the middle of the fourteenth century, presently followed by the Bank of Genoa, which was a vast and active organization before Holland and England had acquired any considerable financial importance.

Political alliances.

In the decisive struggle between royalty and nobility we see industry taking different sides in different places, but always on the same principle,—that of supporting the feebler party, in expectation of reciprocal service, and in the intention of victory. There was no concert in this, but merely natural policy; and we see, accordingly, that the industrial power formed a political alliance with royalty in France, and with the feudal aristocracy in England, notwithstanding the natural sympathy which, as I have explained, would have decided the English case the other way. Here we find the origin of the characteristic differences between French and English industry,—the first tending to centralization, and the second to partial combinations, according to the feudal principles on which each set out. The first is the most natural and favorable to industry, and spread over the greater part of Western Europe; the second was an exceptional case, though shared by some few continental populations. The first encouraged a greater generality, and prepared the working class for an earlier conception of a genuine organization, such as is even yet however too little dreamed of by anybody; whereas, the second encouraged a greater speciality, and thus aggravated the besetting vice of the industrial movement. As an exemplification of the two methods, Louis XI. established the post,—a truly royal intervention in European industry; while the English carried their distrust of centralization so far as to refuse as long as possible the institution of a police sufficient to protect their great cities.

Mechanical inventions.

The Compass.

I mentioned before that the condition of slavery was unfavorable to mechanical inventions: and we may look to this period for confirmation of the converse truth. We must refer to the latter part of the period for the majority of such inventions; but I must point out here that the earlier portion gave us the compass, fire-arms, and the invention of printing. It is true, the compass was invented two centuries before; but it was not till the fourteenth century that it was improved and adapted for use; that is, it lay useless till the extension and improvement of navigation converted it into a practical need. Whether gunpowder was now invented, or revived from disuse, the sudden employment of fire-arms is a sign of the times. Military methods were improved, that the industrial population might defend itself against the military caste without undergoing the long and irksome apprenticeship formerly necessary; and the art was particularly suitable to the paid soldiery, whom kings and cities might thus enable to conquer a powerful feudal coalition. I have before pointed out that this new facility did not protract the warlike period; and we must be very well aware that the prevalence of war does not depend on the excellence of its apparatus; for the warfare of our own time is immeasurably less than our knowledge and resources would enable it to be, if the spirit were not wanting. And again, I think it a mistake to suppose that the increased expense of modern warfare is owing to the introduction of new apparatus. I believe, on the contrary, that if we could compare the accounts of ancient and modern warfare, we should find that the new methods are decidedly economical, and that the increased expense arises from the substitution of mercenaries for volunteer armies,—a change which must have produced the same result, if the weapons had remained the same as of old. Again, I must point out the services rendered to natural philosophy by the scientific pursuit of war,—by means at once of the common interest in those departments of knowledge, and of the special establishments which seem to make the military spirit an instrument, as it were, of modern civilization, through the rational positivity which it has thus acquired.

Fire-arms.

The commonest error in regard to the third of these inventions, is to connect the whole progressive movement with the art of printing, which was only the most powerful material means of its propagation, and therefore of its indirect consolidation. Like its predecessors, and even more than they, this great innovation was a result of the state of contemporary society, which had been preparing for three centuries. In the vaunted days of antiquity, when slavery and war left only a very small number of readers, the ordinary method of propagating writing sufficed, even for occasional extraordinary demands: but the case was far otherwise in the Middle Ages, when the vast clergy of Europe constituted a reading class to whom it was of the utmost importance to render transcription cheap and rapid. During the scholastic period, when the universities became thronged, the matter became one of serious anxiety; and in the twelfth century, the multiplication of copies far exceeded anything that the ancients could have known. And when universal personal emancipation succeeded, and industrial activity spread, and increased ease multiplied the number of readers, and more and more written instruction was required to supply to the lowest classes the want of the oral teaching which was now insufficient, the concurrence of demands, under the æsthetic, scientific, and philosophical pressure of the times is quite enough

Art of Printing.

to account for the invention of printing. No such preparation had ever before been made for the rise of any art as now for that of printing, while yet modern industry had afforded some strong proofs of its aptitude to employ mechanical methods, in the place of human agents. Paper had been invented centuries before,—no doubt because it was wanted for transcriptions; and it would be more reasonable to inquire why the art of printing was so long in coming, than to wonder at its appearance. It was in Germany especially that the need of a better method of multiplying books was felt, during the great controversies about the nationalization of the clergies of Europe. And when the method had been found, there ensued a most important connection between intellectual progress and the spread of a new art, of such industrial value that the guardian powers of industry could not but respect it more and more, and the most obscure policy was compelled to tolerate the free circulation of books, and favor their production, as a source of public wealth. This was first the case in Holland, and then everywhere else, contributing to restrain the retrograde aspirations of the governments, instigated by abuses of the press, such as are mixed up with the noblest services, while the press remains under the liabilities of our spiritual anarchy.—Thus then it appears that while all the conditions were long preparing for these three great inventions, there were no technological difficulties about them which prevented their appearance, when they were sought with a persevering intention. If it be true that they had long existed among Asiatic nations, we have only another proof that they did not originate the great social changes of which they were the instruments and the propagators; for they have produced no such effects in the East. In noticing them, I have for once quitted my principle of generality, in consideration of their importance, and of the erroneous judgment usually pronounced upon them. I need not say that I shall pass over all other discoveries, whatever may be their merit and importance, because these are enough for the purpose for which I diverged from my abstract dynamical analysis. The two great geographical discoveries of that age belong by their results to the next period; but they must be noticed here on account of their derivation from the earlier part of the movement. The expeditions of Columbus and of Vasco de Gama were certainly owing to the disposition of modern industry to explore the surface of the globe, after the school of Alexandria had proved its form, and now that the compass permitted bolder enterprises at sea, at the same time that new fields for commercial activity were wanted. The growing concentration of the temporal power now permitted the necessary accumulation of resources; which was not the case earlier, nor would have been later among powers like the Italian, for instance, which, however eminent its naval force, were occupied with struggles at home. If, as is probable, hardy Scandinavian pirates really visited North America some centuries before, the fruitlessness of their enterprise proves that there was nothing fortuitous

Maritime discovery.

in the achievement when it did take place, and that the social value of such deeds depends on their connection with contemporary civilization. In this case, the discovery of Columbus was prepared for during the fifteenth century by Atlantic excursions of increasing boldness, gradually followed by European settlements.

Second period.

During the second of our three periods, the Protestant, we shall find the positive and the negative progression still coinciding, as before. The industrial movement was obtaining something like regulation, while the revolutionary movement was becoming subject to a directly critical philosophy. The working classes were no longer regarded merely as an auxiliary force which the temporal power would be wise to propitiate by concessions. The advanced concentration of the political power, favorable as it was to enlargement of views, revealed to the modern governments, whether royal or aristocratic, the relation that industry now bore to the rest of the political system. I do not mean that the time was come for rulers to take philosophical views of the necessary preponderance of industry. War was still regarded as the chief end of government; but it was perceived that industry must be favored as the basis of military power. And thus we see that is no fancy of the historian, but necessary fact, that the two kinds of progress became systematic at the same time and in the same degree.

Again, we find in the positive as in the negative case a great difference in the mode of progression, according as it is related to the central or to the local forces of the system; whether the temporal dictatorship in the one case resided in the sovereign or in the aristocracy; and whether, in the other case, the chief industrial cities should preserve their independence, or should give way before wide national organization. In the first instance, indeed, both the monarchial and the aristocratic polity required the sacrifice of the great commercial cities, whose independence had once been necessary, but was now become obstructive, through their mutual rivalry. They were humbled therefore without opposition from any quarter. But they left stronger traces of their original industrial constitution under the rule of the aristocracy than under that of royalty. The old urban privileges were more completely effaced by the systematic action of royalty than by the more desultory action of aristocratic rule. The difference was felt, beyond the period, in the advantages and disadvantages of the two methods, and in the attachment of their respective advocates. The French, or monarchial system, issued in the works which distinguished Colbert's administration, and which exhibited a regulation of industry which, considering the age, I believe to be the finest type of administration that is upon record. But the tendency of monarchy to fall back upon aristocracy prevented the method from being durable; so that it merely yielded a temporary impulse, and indicated what might be done under a future and better-grounded organization. The other method, which originated in Holland, but was best exemplified in England, began to show its true tendencies in the time of Cromwell, though it had been prepared for in the reign of Elizabeth. Its chief advantage was the union between the industrial and the feudal elements, through the active or passive participation of the nobility in industrial operations, which were thus ennobled in the popular view. It was in this way that the prosperity of Venice had been founded three centuries before; and we see in it something that contrasts finely with the stupid contempt of the French aristocracy for the working classes. But the example of Venice shows that this method is not favorable to the prosperity of industry, nor, in the long run, to its organization. It aggravates the tendency to detail, and to national exclusiveness; and it preserves the influence of that element of the feudal system which clings the most pertinaciously to the old *régime*. As for the area occupied by each method,—with the exception of Prussia, which offered an anomalous spectacle of the union of legal Protestantism with genuine monarchy, for reasons which it is not possible for me to go into here,—the connection of industry with the royal power took place in Catholic countries, and with aristocratic power in Protestant countries. The theological spirit is equally adverse to industry in the Catholic and in the Protestant form; but the Protestant had the temporary advantage of encouraging personal activity. The effect was seen in Holland being first, and England afterward, the centre of European industry: but the Protestant nations are probably destined to pay the price of their transient superiority by their comparative inaptitude for a genuine and extensive reorganization.

Colonial system.

One evidence that the industrial movement was becoming organized at this period is the rise of the Colonial system. It is an interesting question whether colonization on the whole advanced or retarded the evolution of modern society. On the one hand, it opened a new career to the military spirit by land and sea, and there was a revival of the religious spirit, from its suitability to the less civilized populations abroad; and thus the theological and military *régime* was protracted, and the time of reorganization was set further off. But again, the new extension of human relations improved the existing idea of the final regeneration, by showing how it was destined to include the whole human race, and thus condemning the policy, then very common, of systematically destroying the races of men, in despair of incorporating them. Again, by the stimulus which colonization imparted to industry, its social and political importance was so much enhanced that, on the whole, I have no doubt that the general progress was accelerated by this great new European event,—though by no means to the extent commonly supposed. It is a true remark of some of the most eminent of the Scotch philosophers, that some countries, which by their geographical position, or from other causes, have had least share in colonization, have benefited quite as much by it as the rest, and some even more. The main diversity in modes of colonization results from its being effected under Catholic and monarchical, or Protestant and aristocratic rule. Dutch colonization, with the regular destruction of products that it caused in the Indian Archipelago, is an example of the last mode, which encourages individual activity and rapacity and national selfishness. In the other case, the enterprise has more of a political than an industrial character. If we compare the colonial system of Spain, and even of Portugal, with that of Holland and England, we find in it, not only a systematic concentration, Catholic and monarchial, of the ruling power, but a complement of the retrograde policy organized at home: for it opened a new sphere of personal advantage to the priesthood and nobility, and at the same time an outlet for the restless activity which imperilled the system in the mother-country. So that I suspect, as several philosophers have done, that for Spain, at least, the colonial movement was a social retardation.

Slavery.

I can not quit this part of my subject without entering my protest, together with that of all philosophy, against the rapacity by which the great colonizing movement has been everywhere disgraced. Three centuries after personal emancipation had been obtained in Europe, Catholicism, in its decay, not only sanctioned but instigated the extermination of whole races, and the institution of a slavery infinitely more dangerous than that which, in its better days, it had so nobly assisted to overthrow. I need not repeat my condemnation of the disgraceful anomaly of modern slavery, nor the grounds of that condemnation. As to the reaction of this monstrous crime on European civilization,—it indirectly favors the retrograde or stationary spirit, by preventing the true philosophical extension of the generous elementary principles of modern progress; since their most active defenders are apt to find themselves checked, in the midst of ostentatious philanthropic demonstrations, by their personal interest in the maintenance of the most oppressive policy. In this particular respect, Protestant nations are at a disadvantage in comparison with Catholic: for, enfeebled as the power of the priests now is, it has mitigated, by a perpetual beneficent intervention, its own great original offence; whereas, the legalized spiritual anarchy of Protestantism leaves entire impunity to private oppression, except that it admits the inert restraint of a few temporal rules, generally framed and always applied by the oppressors themselves. The excuse now commonly offered for slavery, that it promotes the civilization of the enslaved race, will not stand a moment's examination, and is of a wholly injurious tendency to the cause of civilization itself. If the enslavement took place on the spot, under circumstances analogous to those of ancient times, it is conceivable that benefit might arise to both parties at that stage of barbarism: but when the slaves are transplanted to, as it were, a subsequent age, the natural progression of the people of Africa is fatally interfered with. It is fatally rash to attempt to hasten processes so slow and so vast, at the risk of introducing uncontrollable calamities, even if the method were as generous as it is odious. As it is, the promoters of this disastrous institution must at length accept, in their own social retardation and embarrassment, the just punishment prepared for them by all the fundamental laws of human society.

Third period.

Final subordination of the military spirit.

Our third period extends from the expulsion of the Huguenots from France, and the political triumph of the English aristocracy, to the beginning of the French revolution. It is the same which, in the former connection, I called the Deistical period; and here again we find the positive and the negative progression coinciding. In the last period we saw that extending industry was regarded as the necessary basis of military superiority, which was still the chief consideration with governments. But during the period we now have to examine, a remarkable inversion gradually took place; an inversion which must be regarded as the greatest advance which it is possible for society to make during the existence of the old *régime*, and beyond which it is impossible to proceed but by entering upon a total reorganization. Here begins the last phase of warfare,—that series of commercial wars in which, at first spontaneously and then systematically, the military spirit retires behind the industrial, and strives to retain its place in the social economy by conquering advantageous settlements for each nation, or by destroying the resources of foreign competition. Lamentable as have been some of the conflicts of this kind, the policy must be regarded as progress, inasmuch as it announces the decay of military activity, and the preponderance of industry, which is thus established, in a temporal sense, as the principle and the aim of modern civilization. The change was evident enough in the strifes about monarchy and aristocracy, and in other features of the second period; but it was not till the eighteenth century that the subordination of military to industrial action was decisively settled throughout Western Europe,—the Colonial system, founded under the preceding phase, having been the main cause of this kind of conflict.

Spread of industry.

As to the other points of view of the relations of industry,—it advanced more rapidly during the last period in England than on the Continent, because the Protestant spirit, and the close connection between the aristocratic and the mercantile classes, are favorable both to the self-reliance and the selfishness which have hitherto belonged to industrial life; whereas, the lingering influence of Catholicism in continental countries, the greater sociality of temper and manners, the cosmopolitan character of the negative philosophy, and the want of affinity between kings and the industrial classes, have wrought together to leave the superiority to England. That provisional superiority may be no advantage; for it protracts the military and theological system, which is incorporated in their case with the industrial; and it tends to the encouragement of an insatiable cupidity, and the repression of generous national sympathy; and thus there is a risk of future retribution for the provisional industrial prosperity of England.

The interior organization of industry has been largely affected by its peculiarity of offering interest and scope to a variety of minds; so that the most active and energetic men have entered it more and more eagerly as it grew in social importance, while military life became the refuge of men of inferior ability or perseverance,—especially among the lower classes. The flood of cupidity which desolated France when Law's scheme was afloat proved that it was from no intellectual and moral superiority that the proud upper classes despised industrial life, but only from an aversion to work. The spectacle was not so openly shameful in Protestant countries, though the same temper might exist. The alliance between aristocracy and industry must disguise the alienation of spirit: but not the less was the energy of the national mind investing itself in industry, and its indolence, incapacity, and pride, in war. Another interior element of progress was the expansion of the system of public credit, which began, as we have seen, in the Italian and Hanse towns, but which could not fulfil its function completely till industrial interests had become incorporated,—first as a means and then as an end,—with the whole European polity. Its most decisive extension was when, out of the great financial companies, arose the class of bankers, to be the head of the industrial interest, through the superior generality of their habitual views: and from the moment when they became actually a part of the commercial body, instead of being outside of it as at first, they formed a bond between all the other parts, which aided their organization. At this time, again, genuine relations began to be established between science and industry. The opposite elements, the abstract and the practical, had long been approximating, and Colbert had shown the power of their junction. But it was in the eighteenth century that they showed what they could do by their union. Before, there had been scarcely any arts, but navigation and medicine, in which any great scientific progress had been made: now it was not only the whole system of geometrical and mechanical arts, but the more complex and imperfect physical and chemical arts, that rapidly advanced. And now arose in consequence that remarkable intermediate class, small but rapidly augmenting, of engineers, whose business it is, as I pointed out in a previous chapter to regulate the relations of science and industry. Their action in England and France has been characteristic of the social and political differences of the two countries:—the English showing the wonderful resources of free private instinct, backed by voluntary associations; and the French preparing the way for a genuine final reorganization of labor of every kind. Again; during this period, modern industry began to manifest its philosophical character,—till then discernible only by careful historical analysis. The time was come for it to appear as the systematic action of Man upon the external world, guided by the knowledge of natural laws. The two great inventions, of the steam-engine and the balloon, spread the true conception,—the one by its actual operation, and the other by the bold but fairly-grounded hopes, which it awakened. If theology had before disclosed its anti-industrial tendencies, industry now clearly revealed its anti theological character. Under polytheism, the antagonism between the supposed divine order of the universe and Man's power to interfere with that economy for his own advantage, could be evaded: but monotheism placed the question in the front rank by its hypothesis of providential optimism. The admirable organization of Catholicism deferred the settlement of the question by avoiding collision with industry as long as possible; but when the theological system was in decay, and industry was rising from day to day, the final conflict could not but be destructive to the religious view. That view had become totally incompatible with the extension of Man's action upon nature; and thus was the industrial element brought into radical and permanent hostility to the theological and military powers, under whose shadow it had grown up. And thus was the most popular mental action of all brought into alliance with the other forces which were engaged in the destruction of the theological philosophy.

The intellectual movement.

We have now traced the industrial movement through its three periods;—its spontaneous rise, under Catholic and feudal guardianship,—its systematic encouragement by government, as a means of political supremacy,—and its establishment as a permanent end of European policy, with the subjection of war to its service. It is evident that nothing remains to be looked for but the advent of a corresponding political system; of which I shall have more to say hereafter. We must now proceed to survey the intellectual movement, æsthetic, scientific, and philosophical, which was going on at the same time. This review may be very brief in comparison with that which we have just concluded, for the intellectual evolution is less complex than the industrial, less subject to historical misrepresentation, and less important in regard to the constitution of modern society, being restricted to a small class, and capable of a merely modifying action thus far, however, active and eminent its operation is destined to be at a future time. It is not compatible with my object to notice any but the social properties of the three intellectual elements; and I shall not therefore enter on the special history of any of them, but merely sketch their rise, character, and development,—beginning with the æsthetic.

The æsthetic development.

The function of the æsthetic faculties is to afford an ideal and sympathetic representation of human sentiment,—personal, domestic, and social; and their condition therefore can never be any sufficient test of the corresponding civilization. This is the only element of those which I have to consider in this chapter that is common to the military and theological, and the industrial and positive systems. The best way therefore of ascertaining its state at any particular time is, not by regarding it by itself, but by looking at those characteristics of modern civilization with which it is incorporated, to ascertain its share in them, and observe what new properties it may have disclosed. Considering the strong human interests which abounded in the mediæval period, it is evident that the Fine Arts must have been favored by it. The sense of personal independence was then energetic; domestic life had a strength and beauty in it unknown in ancient times; and the defensive wars of the period stimulated social activity. The Catholic and feudal system was undoubtedly more favorable to the Fine Arts than any preceding *régime*, if only it had had more stability. The cathedrals, which were in fact museums of music, painting, sculpture, and architecture, were one evidence of this; and another was the organization which permitted an unequalled encouragement of individual genius. But, on the other hand, the vague, abstract, inflexible character of monotheistic articles of belief was incompatible with æsthetic development; and it was the social condition of the period, and not its philosophy, that was favorable to the Fine Arts; and the case being an inversion of the polytheistic, in which it was the doctrine, and not the corresponding *régime*, that so largely developed æsthetic genius. Under the feudal encouragement of that order of genius, we see it assuming the form of an ideal faith in the old polytheism, Greek, Roman, Scandinavian, or Arab. It appears to me that we here find the cause of the supposed opposition to the Fine Arts and decline of their influence, which may well be ascribed to the neutralizing effect of this logical inconsistency. Depending thus on social influences in that age, the æsthetic action must begin to show itself as soon as the Catholic and feudal constitution was sufficiently mature; and its opening period is marked by the institution of chivalry, while its main development was occasioned, for two centuries onward, by the Crusades, in which the whole moral energy of Europe was concentrated. All historical testimony agrees in asserting the extreme eagerness of all the classes of European society for that kind of mental action, which suited all capacities, affording excitement for the feeble in intellect, and diversion for the strong. And this was happening in the age which moderns have thought proper to call dark, and in the two countries, England and France, where the system of that age existed in its most perfect state. The admiration excited by the Fine Arts, then and there, was far more energetic and universal than any ardor felt by some few ancient peoples for the works of their time. Italy was soon to eclipse every other country; but we have Dante's assurance that the Italian inspiration was derived from southern France, where the feudal system was stronger and the Catholic feebler than in Italy.

We must remember the delay and difficulty that were occasioned by the state of language in that age. There might be little apparent result from this long stage of preparation for the full development of the Fine Arts; but it was not the less true that earnest labor, and much power of an æsthetic kind, were absorbed by this task. Languages, and especially modern languages, are the result of a slow popular elaboration, in which the corresponding civilization is affected: but the work must be taken up and carried out by the higher order of intellect; and the æsthetic order particularly,—both because it is the most naturally active, and because it is concerned with expression, and therefore, in an eminent degree with language. This is particularly the case when the thing to be done is not to create an original language, but to transform an existing one, as a necessary consequence of a new social state. The æsthetic faculties having to represent, in the strength of nature, the ideas and feelings inherent in actual common life, could never speak a dead or a foreign language, except by artificial habit; and we see how they must have been occupied, long and sedulously, in the Middle Ages, in aiding and directing the spontaneous formation of the modern languages, though it is the fashion to suppose them lying idle at the very time that they were laying the foundations of the great social monuments of European civilization. It was poetry chiefly that was thus kept back, and music, in an accessory way; but the other three arts were more or less hindered, through their connection with the chief and most universal.

Intellectual Originality.

The chief feature of the intellect of that age is its originality and popular character, testifying to its being derived from the corresponding social state. Amidst all the reproaches about the abandonment of ancient works, we well know that the reading class of that time, who spoke Latin, must have read the Latin authors very diligently. But there was a growing feeling of the incompatibility between the rising æsthetical spirit and an exclusive admiration of works that related to a state of society now extinct. Besides this, it was insisted by Catholicism that the new social state was better than the old, insomuch that when the so-called restoration of letters took place, and the works of the ancients were brought up again, it was mainly owing to the reaction against the Catholic spirit which set in when it ceased to be progressive. Meantime, the spontaneous character of the new development required its perfect separation from one which belonged to a wholly different social state. For instance, Italy imitated the old Roman monuments; and therefore, while superior to all the rest of the world in other branches of the fine arts, she fell behind in architecture, because Catholicism and feudalism were erecting edifices more adapted to the civilization which they were thus to immortalize in the memory of mankind. We find the same originality in every branch of the arts. In poetry especially we find it in its expression of the manners of chivalry; and again in its disclosures of the new importance of domestic life in the scheme of modern existence. A new order of compositions hence arose, such as the ancients could not have conceived of, because it relates to that private life of which they knew so little, and treats of public life only in so far as it reacts upon the private. This order of works, since so expanded as to have become the exponent of modern civilization, must be referred to the age under our notice; though a servile admiration of ancient literature has caused too great a neglect of the first works in what is significantly called the vulgar tongue,—a term which, however inappropriate now, I accept as historically true.

We have here found the origin of the æsthetic development of modern society: but it is not possible to dwell upon it to any purpose. Not only must the social state be very marked, but it must also be permanent, to favor the effect of the fine arts; because that effect requires a close and established harmony of ideas and feelings between the interpreter and the spectator. These conditions were fulfilled in antiquity; but they have never been so since, in any adequate degree, nor can be till we attain a fully positive state. It is because the intervening period has been a transition stage, that the permanent results of the æsthetic movement have been so disproportioned to the energy of its rise. The anomaly is not explained by any suppositions of the decay of the æsthetic faculties in Man, nor by any complaints of his devotion to the works of antiquity; but it is explained by the instability of Man's social condition, which has been undergoing successive transitions, such as could not but neutralize the necessary universality of art,—strong, and original, and popular as was its first evolution in the Middle Ages. Each social phase was dissolved before its spirit had penetrated the general mind and heart, so as to make it an immortal theme for the poet or the artist. The spirit of the Crusades, for instance, favorable to the loftiest poetry, was lost before the modern languages were formed which should have idealized them for ever: whereas every social condition among the ancients was so durable that, from age to age, Art found the popular passions and affections identical with those which it had to refer to a yet remoter time. The fine arts will never recover their full social efficacy till a perfect reorganization places Man once more in a condition of social stability.

Relation of Art to Industry.

Taking the Middle Ages, as hitherto, as comprehending the nine centuries between the fifth and the fourteenth, we shall find the condition of the fine arts during that period to correspond with the contemporary condition of industry. When serfage succeeded to slavery, the new social state afforded materials for a beginning in art, and an excitement of its faculties: when the town populations were personally emancipated, art was occupied in the preparation of the modern languages: and when the industrial policy of towns was originated, and the rural population finally freed, the arts obtained a direct development, according to the nature of the corresponding civilization. The reign of Charlemagne, occurring about the middle of the period, may be taken as the date of the effectual stimulation of the elements of modern civilization. We have seen what were the characteristics of the nascent art of the period; and we have now to learn what were its characteristics, and what its relation to the pre-existing powers, from the beginning of the fourteenth century onward; in other words, to observe the influence of industrial civilization on Catholic and feudal Art.

The first influence was in awakening mental activity, and in affording ease and security, without which Art could be neither understood nor enjoyed. Mental stimulus is first afforded by gross and urgent wants; and no great enjoyment can attend that sort of activity: and, at the other end of the scale of mental operations, the exercise of the scientific and philosophical faculties is attended with fatigue, which soon becomes insupportable, except in rare cases of organizations peculiarly fitted for abstract contemplation. Between these two extremes, we find the exercise of the æsthetic faculties, affording the pleasure of moderate activity and of an agreeable mingling of thought and emotion, such as the generality of men are capable of enjoying. Thus it appears that Art affords a suitable transition from the active to the speculative life. There can be no doubt that the relation of the arts to practical life became closer in proportion to the substitution of the industrial for military pursuit. While slavery and war made up the social economy, it is clear that the fine arts could not be popular, nor indeed enjoyed at all beyond the limits of the highest class of free men,—except in a partial and circumscribed way, in a portion of Greece. Everywhere else the popular recreation consisted in bloody sports, in imitation of their favorite mode of activity. When industry became a true social element, the Catholic and feudal manners, penetrating the whole of society, prepared its humblest households for more or less enjoyment of Art, which from that time forward was destined to spread among the multitude, and become also a social element, which it had never been, in the slightest degree, in ancient times. In its inverse action, it counteracted the lamentable restriction, mental and moral, which is the attendant danger of industrial activity. Æsthetic education thus begins what scientific and philosophical education must finally achieve; so as to furnish a means of filling up the chasm which is provisionally occasioned by the disuse of religious observances,—highly needful formerly as intellectual relaxation from industrial labor. Throughout Europe the æsthetic movement followed close upon the industrial, tempering its dangers by inciting a more general and disinterested mental activity than was required by daily tasks, and awakening the benevolent affections by means of enjoyments which were vivid in proportion as they were unanimous. In individual cases, too exclusive a devotion to the fine arts may have occasioned mental and moral deterioration; but in a general way, they have prevented too strong a preponderance of the material life, and have sustained a degree of speculative ardor, which will hereafter be instrumental to the highest objects. In a more special way, we may regard the development of the fine arts as being connected with the technical improvement of industrial operations, which can never be perfected among nations untrained to the pursuit of ideal perfection. This is particularly the case with regard to the numerous arts relating to external form, and thus connected with architecture, sculpture, and even painting, through so long a gradation of minute differences that it is sometimes impossible to draw the line between the artistical and the industrial. The technical superiority of populations familiar with art is so evident, that it is the ground of the efforts of modern governments to propagate æsthetic education as a security for industrial success amidst the commercial competition of the European nations.

Critical character of Art

Notwithstanding its natural advantages, Art could only be negative in its character and indecisive in its influence, during the critical period of the last five centuries. If it took for its subject the ancient faith and manner which alone had comprehended universal ideas and sympathies,—the Catholic faith was dying out, and the feudal manners were disappearing before pacific pursuits. Art could not grow up and expand on elements which were dissolving day by day. And the elements which were growing up had not yet so taken possession of the general mind as to afford material for Art. Such strength as it had, passed into natural alliance with the temporal power, and took form in different countries according as that power was monarchical or aristocratic. It was thus spread over all Western Europe, though in unequal force in different countries. Though Art has been accused of engendering national antipathies, from its implication with the proper development of each nation, it has certainly wrought more strongly in the contrary direction, reconciling the nations through the universal and admiring interest excited by masterly works of art toward the people which produced them. Each one of the fine arts has its own proper mode of exciting the universal sympathy of Europe; and of stimulating and aiding mutual communication. The most general and effectual influence of this kind belongs to Poetry, because it has induced the study of foreign languages in a greater degree than any other incitement. Science and philosophy had little to do with the formation of the modern languages; and, from the generality and abstract character of their subjects, they have stood in no great need of them since; so that the æsthetic element has been mainly concerned both in their formation and their propagation.

As to its course, historically regarded, the æsthetic movement was, like the industrial, first spontaneous, then systematic, and finally established as an end (as far as it went) of the modern polity. In the first case, all the fine arts shared in the movement, more or less, and it extended over the countries of Europe; but it was Poetry only, and in Italy alone, that produced characteristic and imperishable works,—those of Dante and Petrarch. Here we see Italy preceding, as in other respects, the rest of Europe by two centuries. The first impulse was certainly original, for Dante's poem was not on the instant responded to by the sympathies which it was fitted to excite; but the unanimous admiration of Europe which presently followed testified to the agreement between this great work and the corresponding state of civilized populations: and not the less for the tardy justice being enjoyed by the poet's successors, Petrarch being in reality crowned as the representative of Dante, and not as the author of Latin poetry, by which only he was then known, and which is justly forgotten at this day. The characteristics of the age appear in Dante's poem, especially in the critical tendency, guided by metaphysics highly unfavorable to the Catholic spirit. It is not only that the work contains severe attacks upon the popes and the clergy: its whole conception is in a manner sacrilegious, usurping as it does the power of apotheosis and damnation, in a way which would have been out of the question during the full ascendency of Catholicism, two centuries earlier. The temporal antagonism of the movement is less marked, because it could not, as yet, be direct; but it appears indirectly in the opportunity it afforded of founding a personal reputation, independent of hereditary superiority, and very soon in rivalship with it.

Retrograde character.

It was about the middle of this period that that action took place which has been commonly called the regeneration of the fine arts, but which was in fact a kind of retrogression, its spirit being a servile and exclusive admiration of the masterpieces of antiquity, which were the expression of a totally different state of society. Its full influence was not felt till a later time; but I note its origin in the season under our notice, because we must attribute to it that neutralizing influence which blighted the promise of the fourteenth century, and rendered the next age so lamentable a contrast to it. Much of the evil was no doubt owing to the religious controversies of the times; but much more is attributable to the passion for Greek and Latin productions, under whose prevalence the originality and popular quality which are the most valuable of æsthetic attributes, languished more and more. The edifices of this period, though improved in technical execution, are not to be compared with the cathedrals of the Middle Ages. At the same time we must remember that this imitation of ancient Art could be no more than a secondary symptom, and not an occasion of the vague and indecisive aspect of modern Art, which we have seen to be owing to the critical character of the corresponding social state. The ancient works had never been really forgotten; they did not interfere with the first rise of modern Art; and their now coming up again was a sign of the decomposition which was proceeding, and also a means, however imperfect and merely provisional, of filling the gap in the career of Art, left between the expiration of the old public sympathy and the growth of the new, under a positive organization. Finding no existing sociality adequate to its objects, Art availed itself of the ancient kind, as it could be known ideally and from the monuments which remained; and this was the abstract medium with which the heterogeneous impressions of the existing environment were united with more or less success. Inadequate and dangerous as was this method, it was the only one then possible, and the only alternative to total anarchy in art. We find accordingly not only Petrarch and Boccacio, but the great Dante himself, earnestly and constantly recommending the diligent study of antiquity as the basis of Art; advice which was erroneous only so far as that it set up as an absolute principle what was only a temporary expedient. The necessity itself enhances our admiration of masterpieces produced under such shackles and with such imperfect means; and it certainly testifies to a growth rather than a decay of the æsthetic faculties in Man. The provisional system which impaired the preceding movement suspended the development of Art during the next. With the originality of the preceding age Art lost its popular quality: and then a public had to be trained for the factitious art which was to have a provisional reign; and that public must consist of privileged classes, placed by an elaborate education at the same point of view with the artists, in order to secure that community of feeling which must exist between the interpreter and the spectator. In a normal condition of art the harmony exists naturally, because the same medium pervades all minds: but in that provisional season a long preparation was necessary; and it was only when that preparation had gone on long enough to prepare a special public, destined to enlargement by means of an education founded on the study of the dead languages, that the æsthetic movement could resume its suspended course, and gradually produce the universal movement which I shall now proceed to describe. This provisional factitious system involved all the fine arts, but in unequal degrees. Its most direct and powerful influence was upon the leading art, Poetry. Sculpture and architecture were more affected by it than painting; and music suffered least of all, being no otherwise involved, than through its connection with poetry.

Political relations.

Arriving at the second period,—that of systematic encouragement of art,—we see at once the advantage that Art had over science in the same stage, inasmuch as it excited no political uneasiness among rulers, while it inspired much more vivid and general sympathy. The popes, who were by that time merely Italian princes, paid little honor to science, but were the most zealous patrons of the arts, which their habits and education disposed them to appreciate. It was however more as a means of influence and popularity, than from taste, that monarchs in general bestowed this encouragement; and there could not be a stronger proof of the social power which Art was acquiring among modern populations.

Of the two forms of political rule, the monarchical and Catholic was more favorable to Art than the aristocratic and Protestant. The more elevated and central authority must be the most propitious to an element which, like the æsthetic, requires and occasions a broad, equable, social sympathy; and we find accordingly that academies of poetry and the arts rose up in monarchical states, and incorporated Art with modern polity. In the other case the local distribution of political power caused the arts to be confided to the irksome and precarious resource of private patronage, among nations whose æsthetic tendencies were already checked by Protestantism; and thus, but for the transient triumph of Elizabeth, and yet more of Cromwell, over the national aristocracy, we should probably not have had the genius of Shakspere and Milton to plead in disproof of the supposed deterioration of the æsthetic faculties in modern times. There is some set-off against the unfavorable influences in the latter case in the superior originality which can work its way through by dint of independence; but the social effect, which we have here to consider, is unquestionably superior where the greatest aid is given to the propagation of Art among the people, and the training of minds in order to a future reorganization. We must refer to this political distinction the peculiarities of the dramatic art, and especially in England. It was not till now that the line was drawn between public and private life in dramatic representation; for in the Greek drama, notwithstanding the chorus, there was nothing that related to polity, except the station of the families whose passions and adventures were exhibited. This was inevitable among a people who could conceive of no social state but their own. Modern tragedy however has a more decided historical character, exhibiting former modes of social life; and its rise had a different aspect, according as it represented ancient or mediæval society. The monarchical authority in France recoiled from the remembrance of the Middle Ages, in which royalty was so weak and aristocracy so strong; and it delighted in the revival of the great scenes of antiquity. Hence Corneille's immortal idealization of the chief phases of Roman society. In England, on the contrary, where the feudal system was much less impaired, the most general sympathies favored the remembrances of the Middle Ages; and Shakspere's representations of them were popular accordingly. The isolation which distinguished the English polity more and more aided this result, and rendered the choice of national subjects almost exclusive. In Spain, under royal and Catholic ascendency, we see that dramatic art was very like the English, and even further from imitation of the ancients; but in that case peculiar predilections existed in favor of mediæval traditions, through the close connection of Catholicism with the corresponding polity. If the Catholic spirit had been equally strong among nations which escaped Protestantism, it would have saved them, in like manner, from their recurrence to antiquity in matters of Art, which was always a token of the instinct of religious emancipation. Thus the Catholic instigation wrought in Spain as the feudal did in England; only more strongly; because there was Protestantism to encounter in England, with its unfavorableness to Art. I have thought it worth while to say thus much to indicate how a sound theory of social progress may throw light on the study of the historical development of Art. I must add that this diversity affects only the representation of public life; whereas, those compositions which delineate private life could relate only to modern civilization. Thus, this class of works, epic or dramatic, must manifest a more complete originality, and obtain a more real and extensive popularity,—public life bearing too small a proportion to private to afford a clear and stable basis to Art. It was for this reason that Cervantes and Molière were always, as now, almost equally popular among various European nations, while it seems scarcely possible for Shakspere and Corneille to be admired by the same people. No great genius has endeavored to produce any dramatic delineation of public life; and the epics which have been attempted have only proved the impossibility of success. The marvellous poem of Ariosto relates much more, in fact, to private than to public life; and as for Tasso's epic, it would be enough to point out its coincidence with the universal success of a composition designed to efface, by means of irresistible ridicule, the last popular remembrance of the same chivalry which Tasso embalmed in glory. The time was evidently past for the full success of such subjects, though they were the finest that modern civilization could offer; whereas, the poems of Homer were as acceptable as ever in Greece after ten centuries, the popular sympathies being still attached to the struggles of their country against Asia. We see the same contrast in the case of Milton, who strove to idealize the principles of the Christian faith at the very time when they were extinguished in the most advanced minds around him. These immortal efforts did not achieve an æsthetic result incompatible with the transitional state of society; but they proved that the poetic faculty in Man was alive and advancing in growth. The operation of Art was of a critical nature, like every other genuine influence of the period. It not only awakened mental activity, but almost all the chief artists joined in attacking the Catholic and feudal constitution, under such forms as suited their art, in Italy, Spain, England, and France. Dramatic poetry was compelled to this by the sacerdotal anathemas aimed at the theatre, when the Church was obliged to relinquish the direction of it. Comedy was the most favorable to this work, because it most clearly reflected the instinct of the time. Molière's satires of the Catholic and feudal spirit, by no means sparing the metaphysical, or overlooking the empirical, extravagances of the influential classes, are an evidence of the tone of dramatic art; and the protection granted to the moral disciplinarian against priestly and aristocratic rancor during the youth of Louis XIV. shows that the monarch had some dim instinct of the tendency of such criticism to aid in the establishment of the monarchical dictatorship.

Spread of Art.

The final period is marked by a development of Art, similar to that of Industry. Hitherto, the ruling powers had patronized Art for the sake of their glory and popularity: but now, the fine arts had advanced so far, and were so firmly established as a part of civilization, that it had become a duty of government to aid them by regular active encouragement, proceeding not from personal generosity, but from public solicitude. At the same time, the growing taste for the fine arts was rendering the life of poets and artists more and more independent, by releasing them from the necessity of that patronage which was still needed by the less popular pursuits of science. The institution of journalism was then becoming practically important,—to literature at first, and then indirectly, by its popularizing influence, to all the other arts. While the æsthetic element was thus obtaining independence and power, its special expansion underwent a remarkable change. The imitation of the ancients must come to an end, and some new form be assumed, yielding impressions more complete and more general. After a season of æsthetic anarchy the discussion arose, about the comparative merits of the ancients and moderns, which may be truly regarded as an event in the history of human progress, as it discredited for ever the old *régime* of Art, which henceforth made only abortive attempts, and proved its incapacity to produce any more masterpieces. But, at the same time, the other system, regarded as peculiar to England and Spain, underwent a similar change, and sank into decline and sterility, through the decay of mediæval associations. The progress that was made was therefore necessarily in those productions that exhibit the interests of private life. On the stage, it is true, there was no surpassing Molière, who remains without a rival; but in the epic delineation of private manners, which is the most original and extensive kind of literary creation proper to modern society, we have, among many others, the masterpieces of Fielding and Lesage, which are a standing testimony against the decline of the poetic faculties of Man. Another character of this phase is the decisive progress of dramatic music, especially in Italy and Germany: and its influence must be powerful in incorporating Art with social life in general.

The demolition of the ancient system by the negative philosophy was extremely unfavorable to Art, in as far as it permitted it to have none but fleeting inspirations, incompatible with all fundamental truth of poetic conception; but, at the same time, the decrepitude of the old *régime* gave a force to the artistic influence, through its connection with the social polity, which is sufficient to support it till the period of reorganization arrives. Thus it is that poets and artists, who were scarcely emancipated from patronage at the beginning of this phase, rapidly rose to be, in some sort, the spiritual leaders of modern peoples against the system of retrograde resistance, which was now to be irrevocably destroyed; the movement being before so prepared for by the metaphysicians that it suited æsthetic better than philosophical intellects, and afforded them a means of activity not then yielded by Art, properly so called. The consequences of so unnatural a state of things could not but be fatal both to society and to Art, if it were too long protracted: and the evil effects are seen in the rule of the men-of-letters, who are the offspring of the transition, and the leaders of the social revolution. We here find the necessary close of the preparatory season of the æsthetic element; for its incorporation with the sociality of a modern age has thus been urged to excess; and the time for reorganization has evidently arrived.

The scientific development

We have now to take a similar review of the scientific evolution, and after that, of the philosophical—the separation of the two being provisional, as I explained before.

When we have completed the process, we shall obtain from their common issue the true immediate principle of the spiritual organization, and therefore of the temporal, which can have no other sufficient basis.

Though the scientific and philosophical faculties are, as I have so often said, the least powerful of any, the scientific and philosophical spirit obtains the rule over human progress, by means of its relation to the great general conceptions which support the whole system of our ideas about the external universe and Man. The slowness of the great changes wrought by this spirit may disguise the reality of its power; but it confirms the eminent difficulty and importance of those changes. We have seen how the primitive speculative exercises of mankind originated a theological philosophy which was modified more and more, and at length destroyed, without any possibility of its being replaced. We have now to explain how, starting from the Middle Ages (the cradle of all great subsequent changes), the human mind, having worn out all the social applications that the old philosophy admitted of, began to turn, though with a very confused instinct of its course, toward the final supremacy of a radically different, and even opposite philosophy, which must be the basis of a new organization. This great philosophical evolution has continued to depend more and more on the scientific development which first undermined the theological system, and transmuted its spirit into the metaphysical, in preparation for a further progress. The close connection of the two evolutions —the scientific and the philosophical—need not prevent our treating of them separately; and in that separate treatment we must take the scientific first, as the philosophical movement would remain unintelligible without it. Our survey may be very brief, as my first book exhibits the historical filiation of the chief scientific conceptions, as well as their gradual influence, at once positive and negative, upon the philosophical education of society. This leaves me nothing to do but to co-ordinate in a general way the historical views which were before isolated—being careful, moreover, to discard all that might degenerate into a concrete or special history of science or philosophy.

New birth of science.

The scientific progression was necessarily connected with the beginnings of natural philosophy in ancient Greece; but it is habitually treated of as directly issuing from the mediæval period, both because of its revival after a long retardation, and on account of the more and more decisive characteristics that it presented. Those differences must not, however, make us forget the connection between the discoveries of the Keplers and Newtons and those of Hipparchus, Archimedes, and their ancient fellowship.

I have shown before that the sharp division between natural and moral philosophy permitted the simpler of the two to be so far independent of the more complex, as that it must be freely rising in the metaphysical scale while the other lingered in the last phase of the theological. Accordingly, natural philosophy remained external to the final organization of Catholic monotheism, which, when compelled to take it in and incorporate it, at once became liable to perversion through that compromise which, under the name of scholasticism, made theology dependent on metaphysics,—as we shall see presently. This last modification of the theological spirit was highly favorable to science, which remained thenceforward under the general protection of the dominant doctrines, till its antitheological character was fully developed. But even before the distinct formation of scholasticism, Catholicism was favorable to natural philosophy by beginning to incorporate it with social life,—its doctrine doing for science in this way what its organization did for art. Relation to Monotheism. We have seen that the passage from polytheism to monotheism was favorable to the scientific spirit, and to its influence on human opinion in general. So transient was the monotheistic philosophy, that, far from interdicting the special study of nature, like polytheism, it rather encouraged its contemplation, that providential arrangements might be admired in detail. Polytheism had connected every leading phenomenon with such particular and precise explanations, that every act of physical analysis stirred up a corresponding religious difficulty; and even when this incompatibility drove inquirers to a more or less explicit monotheism, the spirit of investigation remained shackled by reasonable fears of popular opposition, aggravated by the confusion between religion and polity: so that scientific progress had always been external to ancient society, notwithstanding occasional social encouragements. Monotheism, on the contrary, reducing the whole case to that of vague and uniform divine intervention, was willing that explorers should study the details of phenomena, and even disclose their secondary laws, which were at first regarded as so many manifestations of supreme wisdom. This was a point of extreme importance, as a connection was thus established between all the parts of nascent science. Thus it was that monotheism, which owed its existence to the first stirrings of the scientific spirit, was itself indispensable to its further progress, both in regard to its improvement and its propagation. We find the same action in the Arabian form of monotheism, though less marked; but the early promise of scientific cultivation in Mohammedanism was soon surpassed by Catholicism, which was better furnished for the work by its superior organization, and which aided the progress of knowledge, especially by restricting immediate supernatural intervention to the utmost, and substituting rational explanations for miracles, prophecies, visions, etc., which had come down from polytheism, and were too readily entertained by Islamism. Scientific activity was encouraged also by the institution of a speculative life under Catholicism, by its encouraging certain popular habits of rational discussion, by its adoption of the principle of capacity for office in the place of the hereditary principle, and by the facilities it afforded to the intellectual life. Thus, from the second phase of the mediæval period, Charlemagne, and afterward Alfred, were earnest in stimulating and propagating the study of science; and before the termination of that phase, the learned Gerbert, become Pope, used his power for the general establishment of the new mode of arithmetical notation, which had been ripening for three centuries, but did not come into common use till it was called for by the needs of industrial life. The system of education, ecclesiastical and lay, of that time bears witness to the estimation in which scientific culture was held, —the best minds being carried beyond the literature and metaphysics of the multitude of pupils into mathematical and astronomical studies. It was only during the last of the three phases, however that Catholicism was the best promoter of science. The Byzantine monotheism performed the service during the first phase, when the great western invasions were going forward; and the Arabian during the second, when the Christian world was absorbed by political cares, spiritual and temporal. Then, for three centuries, Arabian students improved upon ancient mathematical and astronomical knowledge, gave us algebra, extended trigonometry, and thus met the growing needs of celestial geometry. When Catholicism had wrought out its polity, and scholasticism ensued, the metaphysical spirit had finally gained the ascendency over the theological, and prepared the way for the positive by permitting the study of the external world to supersede that of isolated Man. The solemn sanction attached to the name of Aristotle was at once a sign of the change and a condition of its continuance, as nothing short of such an authority could restrain the extravagances natural to a philosophy so obtained and so cultivated. We have seen that this revolution caused the decay of the Catholic philosophy. Its converse action was to stimulate scientific progress by incorporating it for the first time with social interests through the dominant philosophy, with which it was now closely connected, and which it was destined to cast out four or five centuries afterward. That new scientific progression has gone on, from that day to this. It began with the cultivation of Greek and Arabian learning, and created Chemistry, at once in the east and in the west; and this fundamental investigation of nature was a step of the highest importance,—chemistry being, as we know, the link between inorganic and organic science. We see how great was the ardor of the most eminent thinkers by the prematurity of some of their efforts, to which we owe, however, amidst their failures, some valuable suggestions; as, for instance, those conjectures of Albertus Magnus which planted the germs of sound cerebral physiology. As for the agreement of the new impulse with the general state of minds, it is proved by the unremitting eagerness which drew crowds of auditors to the lessons of the great European universities, during the third phase of the Middle Age period,—it being certain that the development of natural philosophy had quite as great a share in the interest as the metaphysical controversies of the time. In those days the different sciences were too restricted and too little explored to admit of the speciality of study which, after having been a great benefit, has become a great embarrassment. Under a system of scholastic entities, connected together by the general entity called Nature, an intellectual harmony, scientific and logical, existed which could find no parallel but under the old polytheism, and which can exist again only when our rudimentary positive philosophy shall have become a true organization. The artificial union of theology and science, by a metaphysical bond, could not last; but it had its advantages, as all such efforts have; and they showed themselves especially in the encyclopedical direction of abstract speculation. The monk Roger Bacon, for instance, wrote a treatise containing so vast a variety of views on different orders of phenomena, that most of our scientific men, so scornful about the Middle Ages, are certainly incapable, not only of writing, but even of reading it.

Astrology.

This scientific arrangement, precarious and imperfect, but the best that the times admitted, was effected chiefly through two general conceptions which served as a basis for astrology and alchemy. Nothing can be more erroneous than the superficial popular classification of these with the occult sciences, as they are called, whereby retrograde superstitions are confounded with progressive conceptions. Magic is a relic of polytheistic, or even fetich superstition; whereas, astrology and alchemy are merely a too bold extension of the positive spirit, before the theological philosophy was got rid of. That the two classes have been confounded is owing to religious vindictiveness, and is a natural consequence of the antipathy between science and theology.—No doubt, mediæval astrology exhibits strong traces of theological influence in its supposition that the universe was made for Man—a notion which gave way only on the discovery of the earth's motion: but, apart from that, it is evident that the doctrine rested upon the subordination of all phenomena to invariable natural laws. Its original title of judicial astrology conveyed this. No scientific analysis existed at that time which could assign to astronomical phenomena their true position in general physics; and there was, therefore no principle which could restrain the ideal exaggeration attributed to celestial influences. In such a state of things, it was certainly right that human reason, resting upon the only phenomena whose laws were ascertained, should endeavor to refer to them all other phenomena, even human and social. This was the rational scientific course; and its universality and persistence till the seventeenth century prove its agreement with the corresponding situation. If we look at its action upon the general education of the human mind, we shall find that it was most serviceable in disseminating everywhere a first notion of the subordination of all phenomena to invariable laws, by which rational prevision became possible.

Alchemy.

The general conception of alchemy could not but be less philosophical, from the more complex and less advanced state of the corresponding studies, which were then barely proposed; but its primary rationality is unquestionable. We have seen, in our survey of chemistry, that the phenomena of composition and decomposition could not be even perceived while, as under the old philosophy, but one principle was admitted, and that speculations of that order were necessarily based on Aristotle's doctrine of four elements. Now, these elements were common to almost all substances, real and artificial; so that, while that doctrine prevailed, the famous transmutation of metals could not appear more chimerical than the transformations daily effected by modern chemists among vegetable and animal substances, through the identity of their constituent principles. The absurdity of the bold hopes of alchemy could not appear till the discoveries of less than a century ago furnished the demonstration. Alchemy rendered the same service with astrology in spreading the conceptions of the subjection of all phenomena to invariable natural laws: for, whatever may have been the influence of the theological spirit on the hopes of the alchemists, their perseverance shows their conviction of this truth. The vague expectation of some sort of miracle might help to sustain their courage under perpetual disappointment: but it must have been some conviction of the permanence of natural laws which induced them to pursue their object by other means than prayer and fasting, and religious expedients of that kind. I hope this brief notice may conduce to a tardy rendering of justice to these two great series of labors, which contributed so largely and so long to the development of human reason, notwithstanding all the errors involved in the process. The successors of the astrologers and alchemists not only found science instituted by their perseverance, but the more difficult task achieved—the establishment of the principle of invariable natural laws. No influence less active and profound than theirs could have effected the popular admission of this truth; and we are reaping the fruits of it while we forget the hands that planted. The moral influence of these great provisional conceptions was not less favorable than the intellectual; for astrology engendered a high idea of human wisdom from its power of prevision under natural laws: and alchemy roused a noble sense of human power, before depressed by theological notions, by inspiring bold hopes from our intervention in phenomena which admitted of modification.

First modern phase of progress.

Such was the origin of modern scientific progress, which I have described up to the time when the industrial evolution called upon it for aid in daily labor, and the æsthetic evolution prepared the popular mind for science by rousing the speculative activity of Man. From this point, having examined the period which is beset with injurious prejudices, we can proceed rapidly to review the progressive course of science, during the five last centuries.

Happily, it was already too closely connected with social interests to be endangered by the struggles between popes and kings. It was not rendered secure by such great practical applications as now connect it with broad industrial interests: nor could it depend, like Art, on personal sympathies easily excited; for the scientific faculties of Man are weak; and the leaders of the time were quite satisfied with theological, or at least with metaphysical explanations. Royal lovers of science, like Charlemagne and Frederick the Great, are rare; while princely patrons of Art, like Francis I. and Louis XIV., are much more common: and thus it was only as astrologers and alchemists that scientific men could obtain any welcome; the resources of the universities being then at the command of the metaphysical spirit, from which the scientific was beginning to separate itself. The footing which science had obtained, as astrology and alchemy, was all the more necessary because Catholocism, in its decline, was now manifesting its antipathy to the scientific expansion which it had at first assisted, but the irreligious influence of which it now began to fear. A long array of examples shows us what disastrous oppression science must have undergone if, at that period, astrological and alchemical conceptions had not secured protection to its professors among the clergy themselves.

As for the speculative development, it could not at that time occasion any remarkable progress in knowledge already existing. Chemistry must long remain in the preparatory stage of collecting material; and this process went on rapidly. It might seem that astronomy, and geometry in connection with it, were in the way of improvement; but, in astronomy, epicycles were still resorted to, to sustain the old hypothesis of circular and uniform motion; and geometry was stopped short at special methods and researches, by the imperfection of algebra, and was waiting for Descartes: so that the chief improvement consisted in the simultaneous extension of nascent algebra and of trigonometry, completed in time by the use of tangents; while in astronomy, calculations were beginning to be preferred to graphical procedures; and observations, angular and especially horary, became more precise. This was the time when astrology afforded the strongest stimulus to scientific investigation, by proposing the most extended and decisive aim, with an instrumentality which served as a criterion of celestial theories—that of determining the binary, ternary, and quaternary aspects, which could only be done by diligent study of the heavenly bodies. The moveable feasts of the Catholic church were for a time useful in encouraging this kind of observation; but the influence of astrology was much more powerful and durable. The only radical accession to natural philosophy at this period was from the rise of Anatomy, which had now, for the first time, the advantage of the dissection of the human frame. There had before been some inadequate exploration of brutes; but religious prejudice had prevented the examination of the human body. Though the advance of anatomy could not rival that of chemistry, it was yet of great importance, because it completed the nascent system of modern science, which thus began to extend from the study of the universe to that of Man, with molecular physics for the link between them. Socially, it was of importance as connecting the physicians, as a body, with the speculative class; they having risen from their very low ancient position to an influence nearly rivalling that of the priesthood. The union between biological science and medical art, which we justly complain of now, was necessary then, to sustain anatomical studies in the absence of established theory: and the advantages yielded by astrological and alchemical conceptions were paralleled in this science by the strong belief in a Panacea, which involved the two suppositions of the invariableness of physical laws, and the power of Man to modify his own organism—suppositions which could not but disclose the radical incompatibility between the scientific and the religious spirit.

Second phase

The second phase of the period was, in science as in art, the most eminently progressive, on account especially of the movement which, from Copernicus to Newton, laid the foundation of the true system of astronomical knowledge, which presently became the type of the whole of natural philosophy. As in the other cases, too, governments began to afford systematic encouragement, partly from the general advance of speculation, and partly from the practical value of science, when mathematical and chemical doctrines were in demand for the purposes of a new art of war and an expanding industry. This systematic encouragement was, however, more tardy than in the case of the fine arts; and it was only toward the close of this phase that scientific academies were founded in England and France, the influence of which was chiefly felt in the next phase. They were of great use, however, in sustaining science through the crises of its conflict with the ancient philosophy, from which it was now becoming finally disengaged. It is clear from the nature of the case that science could be protected by the temporal power, which was not concerned in the serious abstract animosities of the spiritual power, whether theological or metaphysical, which was now making its assaults on science; and thus science had even perhaps a more direct interest than art and industry in the establishment of a temporal dictatorship, under one or the other of its forms. If the spiritual power had obtained the ascendency, science would have suffered more eminently than any other interest under its retrograde influence, and social progression would have been thereby found impracticable.

On the same grounds as in the former cases, it appears that the monarchical form of rule was more favorable to science than the aristocratic. Science is not usually attractive to the great: it is less so than art; and it requires a central authority, alike for its support and for its restraint from spreading out into too much speciality. Abstract speculation has held a freer and higher course under royal rule than under aristocratic influence, which has been too apt to subordinate scientific research to practical aims. In the one case, science becomes more favorably incorporated with the social polity, and spreads more certainly among all classes, to the great benefit of general education: and in the other case, there is likely to be a more spontaneous pursuit of science, and a more original treatment of it. The evils in that case, moreover, were more evident in the third than in the second phase, as we shall presently see. Before Protestantism showed its anti-scientific tendencies, it exercised a favorable influence through its principles of free inquiry, which established a state of half-independence strongly conducive to the development of natural philosophy, whose great astronomical discoveries were at this time made among Protestant nations. Wherever the Catholic polity was the most decisively established, the scientific development was retarded;—in Spain, conspicuously notwithstanding the promising beginning made at a former period.

Filiation of discoveries.

The great speculative movement, carried on when the time was ripe by a few men of genius, exhibited two modes of progression, very closely connected; the scientific or positive, consisting of mathematical and astronomical discoveries; and the philosophical and usually negative, relating to the revolt of the scientific spirit against the thraldom of the old philosophy. The rallying-point of this last, in which Germany, Italy, France, and England bore a noble part, was Kepler's investigation, which, prepared for by the Copernican discovery, and the labors of Tycho-Brahe, constitutes the true system of celestial geometry; whilst, giving birth to celestial mechanics, it was connected with Newton's final discovery, through Galileo's mathematical theory of motion, necessarily followed by the achievements of Huyghens. Between these two series, whose succession is direct, the historical method naturally interposes the great mathematical revolution of Descartes, which issued, toward the end of this second phase, in the sublime analytical discovery of Leibnitz, without which Newton's achievement could not have been, as it was, the active principle of the final development of celestial mechanics in the next phase. The filiation of these vast discoveries is too evident to need illustration, especially after the character assigned to them separately in the first part of this work.

Relation of science to old philosophy.

While engaged in these great operations, the scientific spirit had to sustain a perpetual conflict with the dominant philosophy,—the metaphysical no less than the theological; for the astronomical discoveries of Copernicus and Kepler, and even Tycho-Brahe's, with regard to comets, were as distasteful to the one as the other. The antagonism became evident as early as the sixteenth century,—the fate of Ramus proving that metaphysical hatred is no less fatal than theological. We have before seen why Galileo's discovery must be the ground of the chief discussion; and the odious persecution which it occasioned has ineffaceably impressed human memory with the date of the first direct collision between modern science and ancient philosophy. This was indeed the epoch when the invariableness of physical laws was seen to be incompatible with theological conceptions, which were now the only hinderance to the reception of a truth confirmed by long and unanimous experience. In this connection therefore we must historically refer to the contemporary labors of Bacon, and yet more of Descartes, to exhibit the essential characteristics of the positive, as opposed to the theologico-metaphysical spirit. I must however connect with the scientific movement the bold conception of Descartes in regard to the general mechanism of the universe. Descartes probably did not deceive himself about its value or duration, which scarcely extended to two generations; and the existing state of the human mind rendered some such hypothetical venture necessary to the introduction of a sound system of celestial mechanics, such as Huyghens was then silently preparing, by following up the labors of Galileo. We have seen, while treating of the theory of hypothesis, why this mode of transition is the necessary way of passing from inaccessible questions and absolute explanations into the regions of positive knowledge. We see too evident traces of this method still existing in every department but that of astronomy, to be surprised that it once existed there also.

Galileo.

To these great mathematical and astronomical acts of progression, we must add the truly creative works of Galileo on barology, by which natural philosophy was substantially extended. Many fortunate discoveries of a secondary nature followed these, and ulterior creations in acoustics and optics. In those days, nothing but the most exceptional events excited astonishment; and yet those were the days in which, working out and disclosing the destination of modern science to regenerate the humblest elementary notions, Galileo revealed the unsuspected laws of the commonest phenomena, the study of which, in immediate connection with geometry and astronomy, turns out to be nothing less than a disclosure of the department of Physics. The new science assumed its place between astronomy and chemistry: and a new class of inquirers arose, whose special function was to develop the resource of experimentation. If we consider that the geometers and astronomers, who had hitherto been one and the same, now separated, in consequence of the rapid extension of the two sciences, we shall perceive that the organization of scientific labor, especially with regard to inorganic philosophy, which was almost everything at that time, was very much like what it is now. As for the other great departments, it is clear that Chemistry, and yet more Anatomy, were in the preparatory state of accumulating materials,—important as were the new facts which they amassed, and especially Harvey's discoveries about generation and the circulation of the blood, which imparted so strong a stimulus to physiological observation, though the time was not come for incorporating them with any true biological doctrine.

Social relations of science.

It is especially noteworthy that this was the time when the positive spirit began to manifest its true social character and its popular influence. The growing disposition of modern society to grant its confidence to doctrines founded on demonstration at the expense of ancient beliefs appears, toward the end of this period, in the universal admission of the double motion of the earth, a century before the papacy solemnly tolerated it. Thus was a new faith growing up amidst the disintegration of the old, partly from the verification of scientific prevision, and partly from the agreement of competent judges; the two in combination being enough for the satisfaction of minds which, from any cause, were inaccessible to direct demonstration. The growth of such habits of conviction proved that the provisional anarchy on social and moral subjects arose from no disposition to perpetual disorder, but merely from the defect of positive doctrine which could command assent. The action of science was certainly more effectual than that of Art in occasioning a wide social agreement: for Art, though operating more strongly and immediately, is restricted by differences of language and manners; whereas, the general and abstract character of scientific conceptions admits of unlimited intellectual communion. At a time when national divergences were still very great, and when the Catholic bond was dissolved, the universities threw open their doors to foreigners, so as to mark the new speculative class as European, and to afford the best testimony to the cosmopolitan character of the scientific spirit. The influence of that spirit on general education began to appear, though the organized scholastic system was perpetuated, as it is to this day, under some accessory modifications which do not affect its spirit. The mathematical order of studies was gaining upon the literary, as it has done ever since; and as it would have done yet more if the official course of modification had followed the general direction of manners and opinions, instead of being bound to keep up, at all cost, the ancient system of education.

The third phase.

During the third phase, the encouragement of Science, as of Art and Industry, became an express duty of government, the neglect of which would have called forth general censure; and at the same time the increasing implication of natural philosophy with military and industrial processes extended the social influence of science, both by the creation of special schools, and by the formation of the intermediate class whose function was to connect theory and practice. The men of science could not yet pretend to the private independence of poets and artists, whose works were of so much more popular a character; but their small number, and their closer co-operation for the public benefit, conferred an almost equal importance on their social existence. Their position was most favorable in the countries which had kept clear of Protestantism, where the old Catholic spirit of contemplation and of generality was directly united with the boldness and independence of the revolutionary movement. Thus it was in France that the full benefit of royal protection was found, and that science flourished most. In England, the men of science were dependent on private protection, while the exorbitant popular interest in industrial affairs discredited all speculative discovery which did not admit of a direct practical application: and at the same time, the anti-scientific tendencies of Protestantism began to show themselves, not only through the incorporation of Protestantism with the government, in which form they manifested the repugnance of theology to the spread of the positive spirit, but in the mournful individual case of Newton himself, whose old age was darkened by absurd theological vagaries. The exclusive nationality of England was mischievous to science by its active adoption of none but indigenous discoveries. This appears even in regard to the mathematical sciences, universal as they are; for there was a repugnance in England to the common introduction of analytical geometry, which is still too unfamiliar in the English schools, and an analogous prejudice against the employment of purely infinitesimal notations,—so justly preferred everywhere else: and this irrational exclusiveness is all the more repulsive from its contrast with the exaggerated admiration of France for the genius of Newton, for whose sake Descartes was somewhat ungratefully set aside, during the reaction against his Vortex doctrine in favor of the law of gravitation. His merits are even now insufficiently acknowledged, though his genius has never been rivalled but by Newton, Leibnitz, and Lagrange.

Relations of Discoveries.

The scientific progress during the third phase followed two lines in the mathematical province, which remains the chief. The first relates to the Newtonian principle, and the gradual construction of celestial mechanics, whence were derived the various theories of rational mechanics. The other arose out of the Cartesian revolution, and, by the analytical stimulus given by Leibnitz, occasioned the development of mathematical analysis, and a great generalization and co-ordination of all geometrical and mechanical conceptions. In the first direction, Maclaurin and Clairaut gave us, in relation to the form of the planets, the general theory of the equilibrium of fluids, while Daniel Bernouilli constructed the theory of the tides. In relation to the precession of the equinoxes, D'Alembert and Euler completed the dynamics of solids by forming the difficult theory of the movement of rotation, while D'Alembert founded the analytical system of hydrodynamics, before suggested by Daniel Bernouilli: and Lagrange and Laplace followed with their theory of perturbations. On the other line, Euler was extending mathematical analysis, and regulating its intervention in geometry and mechanics;—an ever-memorable succession of abstract speculations, in which analysis discloses its vast fecundity, without degenerating, as it has done since, into a misleading verbiage. It was a curious retribution for the narrow nationality of England that, with the exception of Maclaurin, her men of science could take only a secondary part in the systematic elaboration of the Newtonian theory, which was developed and co-ordinated almost exclusively in France, Germany, and lastly, Italy, represented by Lagrange. In Physics, which had just produced barology and optics, there was now a scientific institution of thermology and electrology, which connect it immediately with chemistry. In thermology, Black made his luminous discovery of changes of state; and Franklin popularized electrology, and Coulomb gave it a certain degree of rationality. Pure astronomy had nearly merged in celestial geometry; so that, among many illustrious observers, we have only to notice one great name in this department—Bradley, whose researches on the aberration of light were certainly the finest contribution to this part of science since Kepler's day.

The chief originality of this phase was owing to the creation of real Chemistry, which underwent a provisional modification very like, in its effects, that of the vortices in relation to celestial mechanics. In this case it was Stahl's conception that fulfilled the provisional office, preceded by Boerhaave's too mechanical attempt, and furthering the more rational course of Bergmann and then of Scheele. Then ensued the experiments of Priestley and Cavendish, preparing the way for the decisive action of Lavoisier, who raised Chemistry to the rank of a true science, intermediate, both as to method and doctrine, between the inorganic and organic philosophy. There was now a preparatory movement even in regard to Biology. There were desultory attempts made under all the three divisions of taxonomy, anatomy, and physiology—uncombined by any common principle, but disclosing the spirit of each. Linnæus followed Jussieu in the first department; Daubenton was making comparative analyses in the second, to be rationalized by the general views of Vicq-d'Azyr: and Haller and Spallanzani were accumulating material, and carrying on experiments in the third. Buffon, with his synthetic and concrete genius, at the same time pointed out the chief encyclopedical relations of the science of living bodies, and its moral and social importance, which were well illustrated also by Leroy and Bonnet. Nothing definitive could be done in this science, however, while the animal hierarchy was as yet hardly recognised in the dimmest way, and the elementary idea of the vital state was still thoroughly confused and uncertain: but it is necessary to point out the first really scientific elaboration of organic philosophy.

Stage of Speciality.

On the whole, this epoch may, I think, be regarded as the best age of scientific speciality, embodied in academies, whose members had not yet lost sight of the fundamental conception of Bacon and Descartes, which considered special analysis to be simply a necessary preparation for general synthesis—always kept in view by the scientific men of this period, however remote its realization might be. The dispersive tendency of labors of detail was as yet restrained by the impulse which induced scientific men, like artists, to aid the great philosophical movement, the anti-theological tendency of which was thoroughly congenial with the scientific instinct; and this adhesion of science to the movement gave it a most serviceable intellectual consistency. The negative philosophy, by its character of generality, repaid provisionally to science the advantage received from it: and the scientific men, like the artists, found in it, besides a social destination which incorporated them with the movement, a kind of temporary substitute for systematic direction. It is the undue protraction of this mental condition in our day which explains the deplorable aversion of both scientific men and artists to all general ideas.

The philosophical development.

The philosophical progression has always depended on the scientific, from the point of their divergence;—that point being the division in the Greek schools between natural philosophy, which had become metaphysical, and moral philosophy, which remained theological, as we have seen. There was, as I have also shown, a provisional fusion between the two philosophies during the scholastic period of the Middle Ages; and this union remained throughout the first phase of the period we are now surveying; so that we have only the two subsequent phases to review, during which the philosophical movement was more and more separated from the scientific. It is necessary to revert briefly to the latter point of departure, in order to ascertain the true nature of the transitory philosophy which, for the last three centuries, science has been destroying.

Reason and faith. Second phase.

Scholasticism had realized the social triumph of the metaphysical spirit, by disguising its organic impotence through its incorporation with the Catholic constitution, the political properties of which rendered an ample equivalent for the intellectual assistance which it provisionally received from the metaphysical philosophy. When this philosophy extended from the inorganic world to Man, implanting its entities in his moral and social nature, monotheistic faith began to be irretrievably perverted by admitting the alliance of reason. No longer resting on a natural universal obedience to a direct and permanent revelation, the faith subjected itself to the protection of demonstrations, which must necessarily admit of permanent controversy, and even of refutation; such as those which, in strange incoherence, were already named Natural Theology. This historical title is a good exponent of the temporary fusion of reason and faith, which could end in nothing but the absorption of faith by reason: it represents the contradictory dualism established between the old notion of God and the new entity of Nature, which were the respective centres of the theological and metaphysical philosophies. The antagonism of the two conceptions was reconciled for the moment by the intervention of the positive instinct, which offered the hypothesis of a God creating invariable laws which he bound himself never to alter, and confided to Nature for special and continuous application;—a fiction which is in close analogy with that of politicians about constitutional royalty. This supposition bears a characteristic metaphysical impress; and it made Nature the main object of contemplation and interest, reserving only a barren veneration for the majestic inertia of the supreme divinity, and therefore placing him at a remote distance from thought, which would naturally seek him less and less. Popular good sense never accepted this doctrine, which neutralized all theological ideas of arbitrary will and permanent action; and it is therefore no wonder that popular instinct urged the charge of atheism against so many learned assertors of Natural theology. At the present time, the case is so inverted, that that which was denounced by public reason as impiety is now considered to be religion *par excellence;* and it is laboriously cultivated by demonstrations which I have shown to be one of the chief causes of the mental destruction of monotheism. We thus see how the scholastic compromise brought about only a thoroughly contradictory situation, which could have no stability, though it was provisionally necessary to scientific progress. The special discussion which best illustrates this general tendency is the controversy of the Realists and the Nominalists, which shows the superiority of mediæval metaphysics, with its infusion of the positive spirit, over the ancient form of it. This debate was in fact, under its apparently idle names, the main struggle between the positive spirit and the metaphysical; and its stages mark the gain of the scientific philosophy upon the metaphysical, in the form of the growing triumph of Nominalism over Realism; for it was the very character of metaphysics to personify abstractions which could have a merely nominal existence outside of our intelligence. The Greek schools had certainly never proposed a controversy so lofty, nor one so decisive, either to break up the system of entities, or to suggest the relative nature of true philosophy. However this may be, it is clear that almost immediately after their combined victory over the monotheistic spirit, and therefore over the last remains of the religious system, the positive and the metaphysical spirit began that mutual divergence which could end only in the complete ascendency of the one over the other. The conflict could not take place immediately; for the metaphysical spirit was busy in supporting the temporal against the spiritual power, while the positive spirit was engaged in amassing astrological and alchemical observations. But when, during the second phase, the metaphysical spirit was enthroned by Protestantism, at the same time that the positive was making discoveries which were as incompatible with the metaphysical as with the theological system, the state of things was changed. The story of the great astronomical movement of the sixteenth century, and many mournful instances of the fate of scientific men, prove how metaphysics had succeeded under different forms, to the domination hitherto exercised by theology. But the logical evolution, properly so called, is the one which can be least effectually restrained, aided as it ever is by those who assume to impede it, and undervalued in its scope till it has proved that scope; and the struggle issued therefore, in the early part of the seventeenth century, in the irreversible decline of the system of entities, which was abrogated in regard to the general phenomena of the external world, and virtually therefore in regard to all the rest.

All civilized Europe, except Spain, took part in this vast controversy, which was to decide the future of the human race. Germany had brought on the crisis, in the preceding century, by the Protestant convulsion, and by the astronomical discoveries of

Copernicus, Tycho-Brahe, and Kepler: but she was now engrossed by political struggles. But England, France, and Italy, each furnished a great warrior in this noble strife,—Bacon, Descartes, and Galileo, who will for ever be regarded as the founders of the positive philosophy, because each was aware of its true character, understood its conditions, and foresaw its final supremacy. Galileo's labors, which were purely scientific, wrought in this movement by freely extending science, and not by abstract philosophical precepts. The works of Bacon and Descartes were alike aimed against the old philosophy, and destined to form the new; and their differences are in remarkable agreement with the nature of each philosopher and with their respective environment. Both showed the necessity of abandoning the old mental system; both set forth the genuine attributes of the new system; and both declared the provisional character of the special analysis which they prescribed as the path of approach to the general synthesis which must hereafter be attained. Agreeing thus far, all else proved the extreme unlikeness between these great philosophers, occasioned by organization, education, and position. Bacon had more natural activity of mind, but less rationality, and in every way less eminence; his education was vague and desultory, and he grew up in an environment essentially practical, in which speculation was subordinated to its application; so that he gave only an imperfect representation of the scientific spirit, which, in his teachings, oscillates between empiricism and metaphysics, and especially with regard to the external world, which is the immutable basis of natural philosophy. Descartes, on the other hand, was as great a geometer as philosopher, and derived positivism from its true source, thus being able to lay down its essential conditions with firmness and precision. The discourse in which he simply narrates his own evolution is an unconscious description of the course of the human mind in general; and it will still be read with profit when Bacon's diffuse elaboration will retain only an historical interest. But, in another aspect, the superiority of Bacon is no less striking,—in the study of Man and Society. Descartes constituted the inorganic philosophy as well as the age allowed, and abandoned the moral and social field to the old methods; whereas Bacon aimed chiefly at the renovation of this second half of the philosophical system, which he foresaw to be the ultimate means of regenerating the human race altogether. These differences must be attributed partly to the diversity of their genius, and partly to the opportunity afforded to Descartes by his position of better estimating the revolutionary state of modern Europe. It must be observed that the tendency of the Cartesian school has been to correct the imperfections of its head, whose metaphysics did not rise in honor with his corpuscular theory; whereas, in England and elsewhere, the Baconian school has applied itself to restrict the noble social spirit of its founder, and exaggerate its abstract inconveniences, sinking his conception of observation into a kind of sterile empiricism, such as is always

Bacon and Descartes.

within the reach of patient mediocrity. Thus, when our men of science desire to give a philosophical appearance to their narrow specialities, they appeal to Bacon and not to Descartes, whose scientific character they depreciate; and yet the precepts of Bacon are quite as hostile as the conceptions of Descartes to pursuits like theirs, which are completely opposed to the common aim of the two great philosophers. Important as were these two schemes, they were not sufficient, even when united, to constitute the positive philosophy. That philosophy had as yet scarcely touched Physics, and had not reached Chemistry; and its extension to moral and social conceptions, which was Bacon's noble aim, was impossible before the advent of biological science. The point of time was remarkable therefore as introducing a new philosophy, and vaguely disclosing the conditions of its development; and all that the two great philosophers proposed was a provisional method, which might render positive all the elements of speculation, in preparation for an ultimate system, which they knew to be unattainable without such preparation. The transitional state of the human mind must therefore endure till Chemistry and Biology should have taken their places among the sciences. Till that should happen, there was really nothing to be done but to modify once more the original separation, decreed by Aristotle and Plato, between natural and moral philosophy, by bringing each of them forward one stage, and thus showing their difference to be more marked than ever; for there is wider difference when natural philosophy is in the positive stage and moral philosophy in the metaphysical stage, than when one was in the metaphysical and the other in the theological. Descartes saw the state of things more clearly and deeply than Bacon, and he applied himself to the extension of positivity to the utmost limit that could be then ventured, even including it in the intellectual and moral study of animals, under his famous hypothesis of the automatism of brutes, thus leaving to metaphysics only the domain which could not be emancipated from it in those days—the study of Man, moral and social. In doing this, he made useless efforts to invest the last functions of the old philosophy with more rationality than really belonged to an expiring doctrine; and therefore the second part of his work was less adapted to his time, and less successful than the first. Bacon's object being, not the distribution of the sciences, but the regeneration of moral and social science, he did not fall under the same liability: but the impossibility of rendering moral philosophy positive at that time compelled his school to recognise the old division, modified by Descartes, provisionally, though not doctrinally. Any attempt at a premature union could merely have set back everything under metaphysical domination, as we see by the attempts of Malebranche and Leibnitz, who labored to set up a consistent system,—the one with his monads and the other with his pre-established harmony. Neither of them succeeded, more or less, in effacing the distinction between natural and moral philosophy; and though we now see the really contradictory nature of that division, we also perceive how its temporary admission must have been absolutely necessary, since the genius of a Leibnitz failed to abolish it.

We thus see the first result of the philosophical stimulus imparted by Bacon and Descartes. The positive spirit obtained complete possession of natural philosophy, while the metaphysical spirit was left for awhile in possession of moral philosophy; and thus the reign of entities, which had been universal, was fatally encroached upon. In the intervening period it appears to me that the pursuit of specialities in study has broken up the metaphysical *régime*, thoroughly and finally. The best minds have, with a few exceptions, turned to science; and philosophy, released from the grave, preparatory study, which was once thought necessary, and floating between science and theology, has fallen into the hands of men of letters, who have made use of it for the demolition of the old system, thus concealing for awhile its organic impotence. It cannot be necessary to treat of the varieties of a philosophy which has no adaptation to the needs of the times. It is notorious that it contemplates the abstract action of the human understanding, in one case through the external conditions, and in another through the internal; and that thus two systems, or two modes, have arisen, equally vicious, because alike separating the two indispensable considerations of the medium and the organism, the combination of which furnishes the only sound basis of biological speculation of any kind. It appears to me that the two errors represent the Catholic and Protestant aspects of the philosophy of Europe: the Catholic metaphysics being more critical, and therefore more tending to the positive, and to the consideration of the external world; whereas, the Protestant metaphysics, incorporated with the governments, and tending to the theological state, must naturally take its stand in Man, and proceed thence to the study of the universe. In England, however, the school of Hobbes formed a memorable exception to this. This transitory school represented by Locke, undertook, under the Baconian instigation, a direct regeneration of moral and social study, and began by a radical criticism, which was therefore of an Aristotelian character, and must be developed and propagated in another direction.

Political philosophy.

Before I go on to the next phase, I ought to point out that some preparation for the renovation of political philosophy was already made by Hobbes and Bossuet. Machiavel had before made some able partial attempts to connect the explanation of certain political phenomena with purely natural causes, though he spoiled his work by a thoroughly vicious estimate of modern society, which he could never sufficiently distinguish from the ancient. Hobbes's famous view of primitive war and the supposed reign of force has been usually misunderstood; but, impartially considered, it will be granted to be a striking primitive view, statical and dynamical, of the preponderance of temporal influences among permanent social conditions, taken as a whole; and also, of the necessarily martial condition of primitive society. This was a sound view introduced in the midst of fantastic hypotheses about the state of nature and the social contract; and it was valuable accordingly. Bossuet's share in the work of preparation is more obvious and less disputed. I have before pointed out the value of his historical survey, where, for the first time, political phenomena are regarded as subject to invariable laws, which, by rational treatment, may be made to determine each other. The theological principle which prevails in this work impairs this very enlightened conception, but can not altogether disguise its importance, nor intercept its beneficial influence on the historical studies of the ensuing period. It was the last great inspiration of Catholicism which, as we have seen, was much more adapted than the negative philosophy to form an estimate of human progress, which indeed the negative philosophy could not justly appreciate at all. The nature of Bossuet's great service appears in its destination; which was to propose systematic history as the necessary basis of political education.

Third phase.

The third phase of the period was, in this case again, simply a prolongation of the second. The Scotch school appears here favorably circumstanced in regard to Morals, by the speculative independence which it enjoyed, both as being Presbyterian in the midst of Anglicanism, and as having no sympathy of principle with either side of the controversy on external and internal conditions of mental development. The value of this school was solely in the merit of its individual thinkers, who had no systematic connection with each other. In an intellectual view, Hume, one of the chiefs of the illustrious group, treated of the theory of causation with great originality and boldness, but with the imperfection inseparable from a sundering of philosophy of science. He here proposed the true character of positive conceptions; and notwithstanding its serious defects, this work appears to me to be the only great step that the human mind has taken toward understanding the relative character of sound philosophy, since the great controversy between the Realists and the Nominalists. In this connection I must point out again the able survey, by Adam Smith, of the history of the sciences, and of astronomy particularly, in which he perhaps approaches even nearer than his friend Hume to the true sense of rational positivity. It gratifies me to record here my special gratitude to these two eminent thinkers, whose influence was very useful to my early philosophical education, before I discovered the great law which necessarily guided it from that time forward.

The Scotch School.

Political philosophy.

Political philosophy made a great advance during the last century, inasmuch as social development became more and more the express object of historical treatment. The process was defective, of course, from the absence of all theory of evolution, by which alone any scientific dignity can be given to works which, without it, remain essentially literary. One class of students were at work whose labors have obtained too little credit,

—the scholars who employed themselves during the second phase as well as the third in elucidating separate points of history by antiquarian and literary research. These labors are, in regard to positive sociology, analogous to those which at a former time accumulated provisional material for the future formation of chemistry and biology; and it is only by means of the lights thus afforded that sociology can begin to rise out of that preparatory state through which every science has passed on its way to its station in systematic positivism.

Idea of Progression.

The one great conception which belongs to this third phase is that of human progress, as an express view. It could only arise from the scientific evolution as a whole; for the idea of true progression could no otherwise be so clearly conveyed as by the succession of terms through an unquestionable filiation. Pascal, who first expressed the philosophical conception of human progress in the maxim which I quoted before, certainly derived it from the general history of the mathematical sciences. The innovation however could not produce any effect while only one kind of evolution was studied; for two are required for generalization on the simplest subjects of speculation; and then a third case is indispensable to confirm the prior comparison. The first condition was fulfilled through the evident conformity between scientific and industrial progression; but no third case was ready: for the spirit of the times caused a strange misjudgment of the merit of the æsthetic movement, which was supposed to be retrograde when it was much otherwise. From a comparison of modern with ancient Art, the discussion extended to other social aspects, and the result was that, though the original question remained doubtful, the idea of human progress, sustained by the universal instinct of modern civilization, was established as systematically as it could be before the clearing up of the apparent anomaly of the Middle Ages,—a difficulty which I may hope to have now removed. Political Economy afforded an indirect aid toward the close of the period, by fixing general attention on the industrial life of modern society, and by marking out the temporal differences between our civilization and that of the ancients, which again favored a political understanding of the intermediate social state, according to the logical rule that a mean condition can be judged of only from a comparison of the extremes. We have seen the result in the enterprises of Turgot, Condorcet, and Montesquieu, whose merits and imperfections I pointed out in the first chapter of this book.

At the close of our review of philosophical progress, from its origin in the Middle Ages to the beginning of the great French crisis, we can not but see that, in the aggregate, made up as it is of a mass of remains, with a few rare and desultory materials of value, it is a merely preliminary affair, which can issue only in a direct institution of human regeneration. Though this conclusion has resulted from each of the several kinds of progress that I have treated of, its vast importance compels me to educe it again from their general approximation, by pointing out the chasms which remain to be filled, and which are common to and characteristic of them all.

Gaps to be supplied.

In each kind of progression, pursued without a sense of its connection with the whole, an instinct of specialty must prevail, exalting the spirit of detail, at the expense of a more general view. This partial and desultory development was obviously the only one possible at a time when all systematic views related to a system which must pass away, and when it was only in such special pursuit that the new forces could manifest their character and tendency. Such a course, however inevitable, could not but produce the anti-social dispositions proper to those preparatory progressions, out of which the elements of future combinations could arise only very gradually,—not having even yet attained any real association. This dispersive empiricism did not come to an end when its destination was fulfilled; and it is now the great obstacle in the way of final regeneration. It insists that neither industry, nor art, nor science, nor philosophy itself, requires or admits of any systematic organization in our modern social state; so that their respective progress, must be left, even more than ever, to special instinct in each case. Now, the most complete exposure of the radical vice of this conception will be found in the proof that each of these four kinds of progress has been more and more impeded by the increase of the primitive empiricism.

In Industry.

With regard to Industry, first, by which modern society is constituted,—there is no case in which there has been stronger opposition to organization,—the doctrines of political economy having been constructed under metaphysical and negative influences.—We have seen that industrial progression was at first concentrated in the towns; and thus the main element, the agricultural, was left so far behind that it adhered more than all others to the ancient organization. We have even seen that, where feudal repression was insufficient, the opposite course of town and country industry often occasioned direct collision. This is the first case in which we recognise the need of a systematic action, bringing into a homogeneous state the elements which must thus be hereafter combined.—Again, if we observe only town industry, we see that, owing to the spread of individualism and speciality, the moral development is far in the rear of the material, though we should suppose that the more Man acquires new means of action, the more moral control is requisite at the same time, that he may not use his new powers to the injury of himself or society. As the whole industrial province lay outside of religious regulation, never having been contemplated in the theological scheme, it was tacitly abandoned to the antagonism of private interests, except that some vague general maxims were preached that there was no power to enforce. Industrial society was thus destitute, from its modern beginning, of all systematic morality which could regulate its various common relations. Among the innumerable connections of producers and consumers, and among the different industrial classes, especially capitalists and laborers, it seems agreed that the spirit of recent emancipation shall be preserved, unimproved,—every one seeking his own interest, without any consciousness of a public function: and this is the state of things to which the economists have given their sanction, in dogmatic form. —Again, the blind empiricism under which the industrial movement has gone on has raised up internal difficulties which can be got rid of in no other way than by a systematic management of the industrial province. The characteristic of modern industry is its improving to the utmost every inorganic agent, leaving to Man little but the intellectual action of directing the apparatus. We have seen how the use of machines followed naturally upon the personal emancipation of laborers; and it is evident that this action upon external nature, under the guidance of science, must tend to elevate not only the condition but the character of Man. But, whatever may be the effects of the great change when it is completely wrought out, it occasions a serious difficulty meantime which must be solved before the industrial movement can fully benefit society. The hap-hazard extension of the use of mechanical agents is directly hostile, in many cases, to the legitimate interests of the most numerous class: and the collisions and complaints thence arising grow more and more serious, and will continue to do so while industrial relations are committed to a mere physical antagonism. I am speaking not only of the use of machinery, but of every kind of improvement in industrial processes. Every accession of the kind diminishes the number of laborers required, and occasions more or less disturbance in the life of the working-classes. This mischief is a consequence of the specializing practice hitherto inherent in modern industry, which has never risen to any comprehensiveness of view, or therefore to any such foresight as might guard society from preventible evils, and help it to bear such as are inevitable.

These three kinds of evidence of the serious deficiencies in the industrial evolution concur in yielding a mournful closing observation on the remarkable disproportion between this particular development and the corresponding improvement in the condition of Mankind on the whole. Mr. Hallam has proved that the wages of labor are sensibly inferior, in comparison with the prices of necessaries, to what they were in the fourteenth and fifteenth centuries—this state of things being explained by many influences—such as the spread of immoderate luxury, the increasing use of machinery, the progressive condensation of the working class, etc. While the poorest laborers obtain conveniences unknown to their ancestors, the ancestors probably obtained, in the early phases of the period, a more complete satisfaction of their main physical wants. The nearer relation of the employed to the employer must, in those days, have secured to the working classes a higher moral existence, in which their rights and their duties must have been better understood and admitted than now, when they are at the mercy of the selfishness which results from a dispersive empiricism. The more we look into this matter, the more we shall see that all interests concur in requiring that organization which historical analysis foreshows. The speculative anticipation of it is no philosophical fancy, but rests on a strong popular instinct, which will make itself listened to wherever it shall find rational organs of expression. The industrial evolution has been thus far only preparatory, introducing valuable elements of genuine and permanent order, and now awaiting the reorganization which will perfect it. In Art. As for Art, it is at present adrift from the old *régime:* it has neither general direction nor social destination; it is weary of the idle reproduction of its negative function under the third phase that we have surveyed; and it is impatiently awaiting the organic stimulus which will at once renew its vitality, and disclose its social attributes. Till then, it merely works so far as to keep its own high order of faculties from atrophy and oblivion.—In Philosophy. I need not point out the nothingness into which Philosophy has fallen, in consequence of its irrational isolation. It requires a kind of mental activity whose very characteristic is comprehensiveness; and it is therefore deteriorated in proportion as it is condemned to separate specialities; and particularly when the subject is one which is naturally inseparable from the general system of human knowledge.—We saw, in a preceding book, how injurious the system of special pursuit has been in every department of In Science. Science. We saw that the mischief was more obvious in proportion to the advancement of the science, and, above all, in the inorganic province: and that the most perfect of the whole range is by no means exempt, as yet, from the lamentable influence of isolation and special pursuit. If all the evils which we now recognise from this cause were not fully developed at the close of the period under notice, they were impending: and it was therefore desirable to recall them here to the memory of my readers, in order to show that the scientific movement requires, like all the rest, the systematic direction now become essential to its speculative progress and its social influence. In the next chapter I shall exhibit more in detail the dangers which arise from the philosophical anarchy of our time. As I am now particularizing the chasms in our science and deficiencies in our practice, I may point out that, during the third phase, biological science was still so immature that there could be no social action of the positive philosophy, to which biological preparation is more essential than any other.

Existing needs. Thus, then, we have seen how, all over Western Europe, the new elements of society were rising up from amid the dissolution of the old: and how the dispersive tendency which was once necessary to positive progression has of late impaired the spirit of comprehensiveness in the advancing classes, while the negative philosophy destroyed it in the powers that were on the decline. We find ourselves therefore living at a period of confusion, without any general view of the past, or sound appreciation of the future, to enlighten us for the crisis prepared by the whole progress yet achieved. We find ourselves, after half a century of tentative confusion, oscillating between an invincible aversion to the old system and a vague impulsion toward some kind of reorganization. The next chapter will show the fitness of the new political philosophy to give a wise systematic direction to this great movement.

CHAPTER XII.

REVIEW OF THE REVOLUTIONARY CRISIS.—ASCERTAINMENT OF THE FINAL TENDENCY OF MODERN SOCIETY.

France first revolutionized.

THE two progressions which were preparing society for its regeneration had advanced at unequal rates—the negative having far outstripped the positive; and thus the need of reorganization was vehemently felt before the method and the means of effecting it were disclosed. This is the true explanation of the vicious course taken by the revolutionary movement to this day. The explosion which ensued, lamentable as it was in many ways, was inevitable; and, besides being inevitable, it was salutary—inasmuch as without it the caducity of the old system could not have been fully revealed, nor all hopes from it have been intrepidly cast away. The crisis proclaimed to all advanced peoples the approach of the regeneration which had been preparing for five centuries; and it afforded the solemn experiment which was necessary to show the powerlessness of critical principles to do anything but destroy. The preparation of the different European nations for the lesson varied, according as the monarchical and Catholic, or the aristocratic and Protestant form of power was established. We have seen that the former was the more favorable to the decay of the old system and the construction of the new; and for various reasons, France was evidently the country to take the lead. The humiliation of the aristocracy had more radically destroyed the old *régime:* the people had passed at once from Catholicism to free thought, thus escaping the dangerous inertia of Protestantism: industrial activity was more distinct and elevated, though less developed than in England, from its great independence of the aristocracy: in Art, the French were in advance of the English, though far behind the Italians; in science, they were foremost; and even in philosophy they were more thoroughly freed than others from the old system, and nearer to a rational philosophy, exempt from English empiricism and German mysticism. Thus, on both positive and negative grounds, France was clearly destined to lead the final revolutionary movement. Not the less for this were all the other nations interested and implicated in her movement—as in former cases when Italy, Spain, Holland, and England had in turn been foremost: and the deep and general sympathy felt in all those countries on the outbreak of the French Revolution, and lasting through the terrible extravagances which ensued, showed that there was a true universality in the movement.

Precursory events.

The convulsion had indeed been clearly foreseen by eminent thinkers for above a century, and had been emphatically announced by three events, unequal in importance, but alike significant in this relation;—first, by the abolition of the Order of the Jesuits, which proved the decrepitude of the system which thus destroyed the only agency that could retard its decay; next, by the great reformatory enterprise of Turgot, the failure of which disclosed the necessity of deeper and wider reforms; and, thirdly, by the American revolution, which elicited the real expectation of the French nation, and therefore its needs. That revolution was regarded as a crisis in which the whole civilized world had a direct interest: and when it is said that France gained much by that event, it should be understood that the benefit to her was simply in the opportunity afforded for the manifestation of her impulses and tendencies; and that she gave more than she received by planting down among a people benumbed by Protestantism, the germs of a future philosophical emancipation.—While all indications thus pointed to a regeneration, there was no doctrine by which to effect it. All negative doctrine and action could be no more than a preparation for it; and yet a negative doctrine was all that then existed. From the attempt to render it organic, nothing ensued but a distribution, or limitation, or displacement of the old authorities, such as merely impeded action by supposing that restrictions could solve political difficulties as they arose. Then was the season of constitution-making, of which I have spoken before, —the application of metaphysical principles, which fully exposed their organic helplessness. Then was the triumph of the metaphysicians and legists, the degenerate successors of the doctors and judges, and the inadequate managers of society, of whose mischievous intervention I have also spoken before. Thus we see what was the necessary direction of the revolutionary crisis, its principal seat, and its special agents. We must now examine its course; and, for that purpose, divide it into its two distinct stages.

First stage. The Constituent Assembly.

At the outset there was naturally some hope of preserving, under some form, more or less of the old system, reduced to its principles, and purified from its abuses. This was a low state of things, involving a confusion of moral and political authority, and of things permanent with things temporary; so that the provisional position was mistaken for a definitive one. The first effort of the French Revolution could be no other than a rising of the popular against the royal power, as all the elements of the old system were concentrated in royalty; yet the abolition of royalty was not contemplated, but a constitutional union of the monarchical principle with popular ascendency; and again, of the Catholic constitution with philosophical emancipation. There is no need to dwell on speculations so desultory, nor to point out that they arose from a desire to imitate England, which affords too exceptional a case to admit of imitation. It was supposed that because the negative course of the one country had answered to that of the other, that England had humbled one of the temporal elements and France the other, they might, by joining forces, destroy the old system altogether. It was for this reason that French reformers turned to England for a pattern for their new work; and again, that the French method is now in favor in the English revolutionary school; each having the qualities that are wanting in the other. But there is, as I showed before, no true equivalence in those qualities; and, if the imitation could have been carried out, it would have been found that the French movement was directed against exactly that political element which gives its special character to the English movement, and which prevents its transplantation to any other soil. It is a mistake to trace back the political constitution of England to the old Saxon forests, and to suppose that it depends on the fanciful balance of powers. It was determined, like every other institution, by the corresponding social state; and if this were thoroughly analyzed, the relations of the English polity would be found very different from what is usually supposed. The most analogous political case is, in fact, that of Venice, at the end of the fourteenth century. The tendency to aristocratic rule is the ground of resemblance. The differences are, that the preponderance of the aristocratic power was more complete in Venice,—that the independence of Venice must disappear under the decline of its special government, whereas that of England may remain uninjured by any dislocation of her provisional constitution,—that English Protestantism secures the subordination of the spiritual power much more effectually than the kind of Catholicism proper to Venice, and is therefore favorable to the prolongation of aristocratic power; and again, that the insular position of England, and her consequent national self-engrossment, connect the interests of all classes with the maintenance of a polity, by which the aristocracy are a sort of guarantee of the common welfare. A similar tendency was apparent in Venice, but with less strength and permanence. It is clear that the continuance of the English polity is due, not to any supposed balance of constitutional powers, but to the natural preponderance of the aristocratic element, and to the union of conditions which are all indispensable, and not to be found in combination in any other case. We thus see how irrational were the speculations which led the leaders of the Constituent Assembly to propose, as the aim of the French Revolution, a mere imitation of a system as contradictory to the whole of their past history as repugnant to the instincts arising from the actual social state; yet the imitation was meditated and attempted in all leading particulars, and, of course, with thorough failure;—a failure which exhibits the most striking contrast on record of the eternity of speculative hopes and the fragility of

Second stage. The National Convention.

actual creations. When the second period of the Revolution was entered upon, the National Convention discarded the political fictions on which the Constituent Assembly had acted, and considered the abolition of royalty an indispensable introduction to social regeneration. In the concentrated form of royalty then existing, any adhesion to it involved the restoration of the old elements which had supported it. Royalty was the last remnant of the system of Caste, the decay of which we have traced from the time that Catholicism broke it up, and left only hereditary monarchy to represent it. Already doomed by that isolation, hereditary monarchy could not but suffer serious injury by the excessive concentration of functions and prerogatives, spiritual and temporal, which obscured its view of its domain, and tempted it to devolve its chief powers on ministers who became less and less dependent. Again, the growing enlightenment of mankind in social matters made the art of ruling less and less one which might be learned in the hereditary way,—by domestic imitation; and the systematic training requisite for it was open to capacity, full as much, to say the least, as to royal birth, which before had naturally monopolized it.

The abolition of royalty was presently followed by that of whatever might interfere with a renovation of the social system. The first instance that presents itself is the audacious legal suppression of Christianity, which proved at once the decrepitude of a system that had become alien to modern existence, and the necessity of a new spiritual function for the guidance of the regeneration. The minor acts of the same kind were the destruction of all former corporate bodies, which is to commonly attributed to a dislike to all aggregation, but which is rather to be referred to a dim sense that there was a retrograde character about all such bodies, their provisional office being by this time fulfilled. I think this applies even to the suppression of learned societies, not excepting the Academy itself, the only one deserving of serious regret; and before this time its influence had become, on the whole, more injurious than favorable to the progress of knowledge, as it is at this day. It should be remembered that the Assembly, largely composed of legists, suppressed the law corporations with others: and that it showed its solicitude for the encouragement of real science by establishing various foundations, and especially by that of the Polytechnic School, which was of a far higher order than any of its predecessors. These are proofs of disinterestedness and of forecast in regard to social needs which should not be forgotten.

Alliance of foes.

A practical character of universality was given to the Revolution by the alliance of European Governments to put it down. During the second phase of social progress the powers of Europe had allowed Charles I. to fall without any serious effort on his behalf; but they were now abundantly ready to go forth against a revolution of which the French outbreak was evidently only the beginning. Even the English oligarchy, which had no great apparent interest in the preservation of monarchies, put themselves at the head of the coalition, which was to make a last stand for the preservation of the theological and military system. This attack was favorable to the Revolution in its second period, by compelling France to proclaim the universality of her cause, and by calling out an agreement of sentiment, and even of political views, such as was required for the success of the noblest national defence that history will ever have to exhibit. It was this also which sustained the moral energy and mental rectitude which will always place the National Convention far above the Constituent Assembly in the estimate of posterity, notwithstanding the vices inherent in both their doctrine and their situation. They wonderfully soon escaped from metaphysical toils, respectfully adjourned a useless constitution, and rose to the conception of a revolutionary government, properly so called, regarding it as the provisional resource which the times required. Putting away the ambition of founding eternal institutions which could have no genuine basis, they went to work to organize provisionally a temporal dictatorship equivalent to that gradually wrought out by Louis XI. and Richelieu, but much more responsive to the spirit of the time and the end proposed. Based on popular power, declaratory of the end proposed, animating to the social affections and to popular self-respect, and favorable to the most general and therefore the deepest and highest social interests, this political action of the Convention, supported and recompensed by sublime and touching devotedness, and elevating the moral temper of a people whom successive governments have seduced into abject selfishness, has left ineffaceable impressions and deep regrets in the mind of France, which can never be softened but by the permanent satisfaction of the corresponding instinct. The more this great crisis is studied, the more evident it is that its noble qualities are ascribable to the political and moral worth of its chief directors, and of the people who supported it so devotedly; while the serious errors which attended it were inseparable from the vicious philosophy with which it was implicated. That philosophy, by its very nature, represented society to be wholly unconnected with past events and their changes, destitute of rational instigation, and indefinitely delivered over to the arbitrary action of the legislator. It passed over all the intervening centuries to select a retrograde and contradictory type in the ancient form of civilization, and then, in the midst of the most exasperating circumstances, appealed to the passions to fulfil the offices of the reason. Such was the system under which the political conceptions of the time must be formed, if formed at all; and the contrast between the action and the philosophy of that day will for ever excite the admiration of philosophers on behalf of the noble results that were produced, and their indulgence for such extravagances as were worthy of reprobation.

The proper close of that provisional polity would have been when France was sufficiently secured against foreign invasion; but the irritations of the time, and the vices of the negative philosophy caused its protraction, under an increasing intensity; and hence the horrible vagaries by which the period is too exclusively remembered. Now appeared the difference between the schools of Voltaire and Rousseau, which had co-operated during the great revolutionary crisis. The school of Voltaire, progressive in its way, regarded the republican dictatorship as an indispensable transition stage, which it took the chief credit of having instituted, and always supposed the philosophy which directed it to the merely negative: whereas, the school of Rousseau, retrograde in its way, took the doctrine for the basis of a direct reorganization, which it desired to substitute for the exceptional system. The one showed a genuine though confused sense of the conditions of modern civilization, while the other was bent on an imitation of ancient society. The latter school prevailed, when it became a practical question what the philosophy could do in the way of organization; and when the political school had the field to itself, and proceeded to action, it proved how the metaphysical philosophy, disguised as antique civilization, was absolutely hostile to the essential elements of modern civilization. When the negative progression was used for organic purposes, it turned against the positive progression, injuring the scientific and æsthetic evolutions, and threatening the total disorganization of the industrial, by destroying the subordination of the working-classes to their industrial leaders, and calling the incapable multitude to assist directly in the work of government.

Thus we see what the course really was, as a whole, which is usually rendered unintelligible by attempts to ignore one or another of its parts. The republican period proposed a substantive political plan, in a much more complete and energetic way than its constitutional predecessor had done; and that programme, which abides in all memories, will indicate, till the day of realization arrives, the final destination of the crisis, notwithstanding the failure of the experiment, through the effects of the means. All criticism and reproach about the failure can attach only to the instruments which caused it, and can never gainsay the fundamental need of reorganization, which was as keenly felt by the masses then as at this day. There can not be a stronger confirmation of this than the remarkable slowness of a retrograde movement which was instinctively felt to be incompatible with the popular state of mind, and which found it necessary to make long and irksome political circuits to restore, under an imperial disguise, a monarchy which a single shock had sufficed to overthrow: if indeed we can speak of royalty as having been re-established at all, while it could not pass peaceably from kings to their natural successors, and had virtually lost the hereditary quality which distinguishes genuine royalty from dictatorship.

Constitutional attempt.

When the rule of the Convention was over, the retrograde action made itself felt first by reverting to the last preceding step,—the constitutional notion. It attempted a blind imitation of the English, by parcelling out and balancing the fractional parts of the temporal power, as if any stability was really to be looked for in a political anomaly so imported. The party which intended to be progressive was carrying forward the negative movement, so as to dissolve the most elementary institutions of society. Both proceeded on the supposition that society was entirely at their disposal, unconnected with the past, and impelled by no inherent instigation; and they agreed in subjecting moral regeneration to legislative rules;—much as they continue to do at this day. Such political fluctuation, endangering order, and doing nothing for progress, could have no other issue than in Monarchy. This last test was necessary to prove what kind of order was really compatible with complete retrogradation; a point which could never be settled but by experiment. The issue was hastened by the growth of the military power,—the revolutionary war having ceased to be defensive, and become eminently offensive, under the specious temptation of propagating the movement. While the army remained at home under civic influences, the preponderance of the civil over the military power had been more conspicuous than in any known case of military activity; but when the army was in remote places, uninformed of national affairs, it assumed a new independence and consistency, became compacted with its leaders, and less and less civic in its temper as it was needed for the repression of the barren social agitation of the time. A military dictatorship was the unavoidable consequence; and whether its tendency should be progressive or retrograde depended, more than in any other case on record, on the personal disposition of that one of the great revolutionary generals who should assume the post. The great Hoche seemed at first to be happily destined for it; but by a fatality to be eternally deplored, the honor fell upon a man who was almost a foreigner in France, brought up amidst a backward civilization, and remarkably and superstitiously adoring the ancient social hierarchy; at the same time that his enormous ambition was no sign, notwithstanding his prodigious charlatanism, of any eminent mental superiority, except a genius for war, much more connected, in our times, with moral energy than with intellectual vigor. The whole nature of Napoleon Bonaparte was incompatible with political ability; with any conception of social progression; with the mere idea of an irrevocable extinction of the old theological and military system, outside of which he could conceive of nothing, and whose spirit and conditions he yet failed to understand: as he showed by many serious inconsistencies in the general course of his retrograde policy, and especially in regard to the religious restoration, in which he followed the tendencies of the populace of kings.

Military ascendency.

Napoleon Bonaparte.

The continuous development of military activity was the foundation, necessary at any cost, of this disastrous domination. To set up for awhile a system thoroughly repugnant to social conditions, it was necessary to enlist and humor, by perpetual stimulation, all the general vices of mankind, and all the special imperfections of the national character; and above all, an excessive vanity, which, instead of being carefully regulated by wise opposition, was directly excited to something like madness, by means derived, like all the rest of the system, from the most discredited customs of the ancient monarchy. Nothing but active warfare could have intercepted the effect of the ridicule which could not but be excited by attempts so ill-suited to the age as Bonaparte's restoration of a nobility and a priesthood. In no other way could France have been oppressed so long and so shamefully. In no other way could the army have been seduced into forgetfulness of its patriotism, and tyranny toward the citizens, who must henceforth console themselves under oppression and misery with the childish satisfaction of seeing the French empire extend from Hamburg to Rome. The Convention had raised the people to a true sense of brotherhood through the medium of self-respect, equally fostered in all: Bonaparte perverted the sentiment into an immorality by offering, as a reward for popular co-operation, the oppression and pillage of Europe. But it is needless to dwell on this desolate period, except for the purpose of deriving from it such dearly-bought political instruction as it may yield. The first lesson is, that there is no security against fatal political versatility but genuine political doctrine. The retrograde policy of Bonaparte would have had neither allies nor support, if the people had been saved from the experience of the last part of the revolutionary crisis, and from the demoralizing influence of a negative philosophy, which left them open to the temptation of return to a system which their strong repugnance had so lately overthrown. The second lesson is of the necessity of active and permanent warfare as the foundation of a retrograde system, which could in no other way obtain any temporary consistence: and this condemns as chimerical and disturbing a policy which depends on a condition incompatible with modern civilization as a whole. It is true, the revolutionary warfare was defended as the necessary means of propagating revolutionary benefits: but the result is a sufficient reply to the sophism. The propagation was of oppression and pillage, for the sake of enthroning a foreign family: and the action upon other nations was very unlike that proposed by the first sincere soldiers of the Revolution: while, in Paris, the leaders of the regeneration of the world were ignominiously beguiling their characteristic activity with the rivalries of actors and versifiers, Cadiz, Berlin, and even Vienna, were echoing with patriotic songs and acclamations,—generous national insurrections having once more bound together the peoples and their rulers, and popular rights and regenerative action being covered with disgrace as deep as the silence in which the revolutionary hymns of France were buried. France was then subjected to a dislike and fear which have never since ceased to injure her name, and the cause which is bound up with it.

This system, founded on war, fell by a natural consequence of the war, when the resistance had become popular and the attack despotic. There can be no doubt in any impartial mind that the fall of Bonaparte was very welcome to the French nation in general, which, besides its sufferings from oppression and poverty, was weary of a state of perpetual fear of the only alternative,—the humiliation of its arms or the defeat of its dearest principles. The only cause of regret is that the nation did not anticipate the catastrophe by popular insurrection against retrograde tyranny, before its country underwent the disgrace of invasion. The humiliating form of the overthrow is the only pretence on which the national glory can be connected with the memory of the man who, more injurious to human kind than any other personage in history, was always and peculiarly the worst enemy of a revolution of which he is sometimes absurdly supposed to be the chief representative. The monarchical spirit which he had striven to restore, and the political habits formed under his influence facilitated the return, when he fell, of the natural heirs of the French throne. They were received without confidence, without fear, and with some hopes from the discipline they had undergone which were not fulfilled. The people supposed they must see, as all France did, the connection between conquest and retrogradation, and that both were detested: and the Bourbons supposed that the people, having allowed their restoration, were favorable to their ideas of sovereignty. The people would have left royalty to such fate as might have ensued from domestic dissensions, if the disastrous episodical return of Bonaparte had not once more united all Europe against France, and deferred for fifteen years, at a heavy cost, a substitution of rulers which had clearly become inevitable.

Restoration of the Bourbons.

Once more constitutional discussions abounded, and a third attempt was made to imitate the English parliamentary system,—the remains of the imperial system seeming likely to answer for the aristocratic element. The people, however, had long been disheartened about social regeneration, and were bent on profiting by the state of peace for the furtherance of industrial interests: and, for a want of sound theory, the new experiment, more durable, more peaceable, and therefore more decisive than any former one, soon disclosed the anti-historical and anti-national character of the enterprise, and its total disagreement with the social environment. In England, the royal power was a great sinecure granted to the nominal head of the British oligarchy, with the name of hereditary sovereignty, but with little more real power than that of the Doges of Venice. This was not the French notion of monarchy; but any attempt to imitate it in France, could lead to nothing but a neutralizing of royalty; and the more decisively in this case, because, under the new forms, the adhesion of the sovereign was made specially voluntary. This is the juncture to which, in the history of the modern transition, we must refer the direct dissolution of the great temporal dictatorship in which the whole movement of decomposition had been concentrated, from the time when Louis XI. wrought at it, and Richelieu completed it. The form of dissolution now was

—opposition between the central and local powers,—between imperfect royalty and the partial action of a popular assembly; under which all unity of direction disappeared, and each party sought a preponderance which was impossible to either. Bonaparte himself would have had to encounter a similar liability, sooner or later. The ministerial power also testified by its growth to the restriction of royalty. It had been, under the second modern phase, an optional emanation of power: it was now an established substitution, tending more and more to independence. This sort of spontaneous abdication helped the political dispersion, which seemed to be thereby erected into an irrevocable principle. The two polities were now in something like the same position that they were in before the revolution; only that the progressive school had avowed their end and proved the insufficiency of their means: and the retrograde party understood rather better the conditions of the *régime* it desired to restore. Now was the time for the stationary school to intervene, borrowing from each of the others the principle which can only neutralize each other; as, for instance and especially, when it sought to reconcile the legal supremacy of Catholicism with real religious liberty. I have shown before what are the moral and political consequences of such an intervention. As soon as the hopeless reaction appeared to threaten the revolutionary movement, it fell by a single shock; an event which might convince doubters that the fall of Bonaparte was owing to something more than the desire for peace,—to the aversion inspired by his tyrannical retrogression. It was now clear that order and peace would not satisfy the nation, which must have progress also.

Fall of the Bourbons.

The great characteristic of the policy which succeeded the flight of the elder Bourbons was its implicit voluntary renunciation of regular intellectual and moral government, in any form. Having become directly material, the policy held itself aloof from doctrines and sentiments, and concerned itself only with interest, properly so called. This was owing, not only to disgust and perplexity amidst the chaos of conceptions, but to the increasing difficulty of maintaining material order in the midst of mental and moral anarchy; a difficulty which left no leisure or liberty to government to think of anything beyond the immediate embarrassment, or to provide for anything higher than its own existence. This was the complete political fulfilment of the negative philosophy, all functions of government being simply repressive, unconnected with any idea of guidance, and leaving all active pursuit of intellectual and moral regeneration to private co-operation. A system of organized corruption was the necessary consequence, as the whole structure must otherwise be liable to fall to pieces at any moment, under the attacks of uncontrolled ambition. Hence the perpetual increase of public expenditure, as an indispensable condition of a system boasted of for its economy.—While closing my elucidation of the decay of the great temporal dictatorship, I must just observe on the novelty of the situation of a central power

The next reign.

to which we may hardly apply the term royal, as all monarchical associations had vanished with the political faith that sanctioned them, and whose hereditary transmission appears extremely improbable,* considering the course of events for half a century past, and the impossibility that the function should ever degenerate into the mere sinecure that it is in England; a condition which requires that genuine personal capacity which rarely descends from father to son. Meantime the encroachments of the legislature on the so-called royal power,—the forcing of its organs upon it, without liberty of choice, so that the action of government is in reality transferred to any one who may for the moment be in a position of parliamentary ascendency,—the independence of the ministers who might presently determine the abstraction of the royal element altogether,—these dangers would render the royal function a totally impracticable one if it were not administered with personal ability, confined to the maintenance of public order, and so vigilant and concentrated as to have the advantage over the desultory and contradictory ambition of men who are appeased by new distributions of power and frequent personal changes. In this provisional state of affairs, when the official system declines the spiritual reorganization for which it feels its own unfitness, the intellectual and moral authority falls into the hands of anybody who will accept it, without any security of personal aptitude in regard to the most important and difficult problems that have ever engaged or can engage human thought: hence the reign of journalism, in the hands of literary men and lawyers, and the hopeless anarchy which some of them propose and all of them, in their collective capacity, illustrate. The power actually possessed by this illegal social authority appears to me a kind of imperfect recognition of the proper priority of intellectual and moral regeneration over mere political experiment, the efficacy of which is wholly exhausted as long as it is separated from the philosophical guidance of the higher renovating agency.

Extension of the movement.

The actual results of this last period consist of the extension of the crisis to the whole of the great European community, of which France is merely the vanguard. The germs of progress could not but be checked everywhere while it appeared that they failed in France; and the propagation of the movement was resumed only when the cause of the failure in France was made apparent. The imitation of the English type was never carried very far; for Catholic nations observed its effect in France; and even in Germany, where the aristocratic element is least reduced, no substantial experiment was tried, while the spectacle was before the world of the revolutionary excitement penetrating the British organization itself. There was no encouragement to transplant a system whose type was attacked at home. The negative doctrine presided over political movement everywhere; but it was nowhere so put to the trial as in France; and thus its radical impotence was universally manifest, without the need of any other nation undergoing the dreadful experience which had been endured by the French people for the benefit of all others. I observe lastly, that the common movement is rendered secure by this decisive extension. The French revolutionary defence first guarantied its safety; and it now rests upon the impossibility of any serious retrograde repression, which must be universal to be of any effect; and which cannot be universal, because the nations will never again be seriously stirred up against any one of their number, and armies are everywhere engaged, for the most part, in restraining interior disturbance.

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* Published in 1842.

We have now reviewed the five periods of revolutionary crisis which have divided the last half century; and the first consideration thence arising is of the necessity of a spiritual reorganization, toward which all political tendencies converge, and which awaits only the philosophical initiative that it requires. Before proceeding to discuss and supply that need, I must present a general view of the extinction of the theological and military *régime*, and the rise of a rational and pacific system, without regard to particular periods. It is necessary thus to estimate the natural and rapid fulfilment of the slow negative and positive movement of the five preceding centuries.

Completion of the theological decay.

We must begin by considering the prolongation of the political decay; and the theological part of it first, as the chief basis of the old social system. The revolutionary crisis completed the religious disorganization by striking a decisive blow at the essential conditions, political, intellectual, and moral, of the old spiritual economy. Politically, the subjection of the clergy to the temporal power was much aggravated by depriving them of the legal influence over domestic life which they retain in appearance in Protestant countries; and again, by stripping them of special property, and making them dependent on the annual discussion of an assembly of unbelieving laymen, usually ill-disposed toward the priesthood, and only restrained from practically proving it by an empirical notion that theological belief is necessary to social harmony. Whatever consideration has been shown them has been on condition of their renouncing all political influence, and confining themselves to their private functions among those who desire their offices. The time is evidently near when the ecclesiastical budget will be suppressed, and the religious part of society will be left to support their respective pastors. This method, which is highly favorable to the American clergy, would be certain destruction in France, and in all countries nominally Catholic. The intellectual decay of the theological organization was accelerated by the revolutionary crisis, which spread religious emancipation among all classes. Such enfranchisement cannot be doubtful among a people who have listened in their own cathedrals, to the direct preaching of a bold atheism, or of a deism not less hostile to ancient faith: and the case is complete when we add that the most odious persecutions could not revive any genuine religious fervor, when its intellectual sources were dried up: and any testimony of the kind that has been alleged in such instances has not been of the spontaneous sort that is socially valuable, but the result of retrograde prepossessions, imperial or royal.—A persuasion which lasted longer was that the principle of all morality was to be found in religious doctrine. After minds of a high order had obtained theological emancipation, many private examples,—and the whole life of the virtuous Spinoza for one,—indicated how entirely all virtue was independent of the beliefs which, in the infancy of humanity, had long been indispensable to its support. In addition to this case of the few, the many exemplified the same truth,—the feeble religious convictions which remained to them during the third phase having obviously no essential effect on conduct, while they were the direct cause of discord, domestic, civil, and national. It is long, however, before any habitual belief yields to evidence; especially on matters so complex as the relations of morality; and we have seen that there is no virtue which did not in the first instance need that religious sanction which must be relinquished when intellectual and moral advancement has disclosed the real foundation of morals. There has always been an outcry, in one direction or another, about the demoralization that humanity must undergo if this or that superstition were suppressed; and we see the folly, when it relates to a matter which to us has long ceased to be connected with religion; as, for instance, the observance of personal cleanliness, which the Brahmins insist on making wholly dependent on theological prescription. For some centuries after Christianity was widely established, a great number of statesmen, and even philosophers, went on lamenting the curruption which must follow the fall of polytheistic superstitions. The greatest service that could be rendered to humankind while this sort of clamor continues to exist, is that a whole nation should manifest a high order of virtue while essentially alienated from theological belief. This service was rendered by the demonstration attending the French Revolution. When, from the leaders to the lowest citizens, there was seen so much courage, military and civic, such patriotic devotedness, so many acts of disinterestedness, obscure as well as conspicuous, and especially throughout the whole course of the republican defence, while the ancient faith was abased or persecuted, it was impossible to hold to the retrograde belief of the moral necessity of religious opinions. It will not be supposed that deism was the animating influence in this case; for not only are its prescriptions confused and precarious, but the people were nearly as indifferent to modern deism as to any other religious system. This view,—of religious doctrine having lost its moral prerogatives,—concludes the evidence of the revolutionary crisis having completed the decay of the theological *régime.* From this date Catholicism could be regarded only as external to the society which it once ruled over; as a majestic ruin, a monument of a genuine spiritual organization, and an evidence of its radical conditions. These purposes are at present very imperfectly fulfilled, —partly because the political organism shares the theological discredit, and partly from the intellectual inferiority of the Catholic clergy, who are of a lower and lower mental average, and less and less aware of the elevation of their old social mission. The social barrenness of this great organization is a sad spectacle: and we can hardly hope that it can be made use of in the work of reconstruction, because the priesthood has a blind antipathy to all positive philosophy, and persists in its resort to hopeless intrigue to obtain a fancied restoration. The obvious probability is, that this noble social edifice will follow the fate of polytheism, through the wearing out of its intellectual basis, and be wholly overthrown, leaving only the imperishable remembrance of the vast services of every kind which connect it historically with human progress, and of the essential improvements which it introduced into the theory of social organization.

Decay of the Military System.

Turning from the religious to the civic system, we find that notwithstanding a great exceptional warfare, the revolutionary crisis destroyed the military no less than the theological system. The mode of republican defence, in the first place, discredited the old military caste, which lost its exclusiveness; its professional practice being rivalled by the citizens in general, after a very short apprenticeship. Popular determination was proved to be worth more than tactics. Again the last series of systematic wars,—those undertaken on behalf of Industry,—were now brought to an end. It was only in England that this old ground remained; and even there it was encroached upon by serious social anxieties. The colonial system was declining everywhere else; and its existence in the British empire is doubtless a special and temporary exception which may be left to find its own destiny, unmolested by European interference. The independence of the American Colonies introduced the change; and it went forward while the countries of Europe were engrossed with the cares of the revolutionary crisis: and thus disappeared the last general occasion of modern warfare. The great exceptional warfare that I have referred to as occasioned by an irresistible sway of circumstances must be the last. Wars of principle, which alone are henceforth possible, are restrained by a sufficient extension of the revolutionary action through Western Europe; for all the anxiety and all the military resources of the governments are engrossed by the care of external order. Precarious as is such a safeguard, it is yet one which will probably avail till the time of reorganization arrives, to institute a more direct and permanent security. A third token of military decline is the practice of forced enlistment, begun in France under the pressure of the revolutionary crisis, perpetuated by the wars of the Empire, and imitated in other countries to strengthen national antagonisms. Having survived the peace, the practice remains a testimony of the anti-military tendencies of modern populations, which furnish a few volunteer officers, but few or no volunteer privates. At the same time it extinguishes military habits and manners, by destroying the special character of the profession, and by making the army consist of a multitude of anti-military citizens, who assume the duty as a temporary burden. The probability is, that the method will be broken up by an explosion of resistance; and meantime it reduces the military system to a subaltern office in the mechanism of modern society. Thus the time is come when we may congratulate ourselves on the final passing away of serious and durable warfare among the most advanced nations. In this case as in others, the dreams and aspirations which have multiplied in recent times are an expression of a real and serious need,—a prevision of the heart rather than the head, of a happier state of things approaching. The existing peace, long beyond example, and maintained amidst strong incitements to national quarrels, is an evidence that the change is more than a dream or an aspiration. The only fear for the maintenance of this peace is from any temporary preponderance in France of disastrous systematic movements; and these would be presently put a stop to by the popular antipathy to war, and experience of the terrible effects thus induced.

There is nothing inconsistent with this view in the fact that each European nation maintains a vast military apparatus. Amies are now employed in the preservation of public order. This was once a function altogether subordinate to that of foreign warfare; but the functions are reversed, and foreign war is contemplated only as a possible consequence of a certain amount of domestic agitation. While intellectual and moral anarchy render it difficult to preserve material order, the defensive force must equal at all times the insurrectional; and this will be the business of physical force till it is superseded by social reorganization. As for the time, when this martial police will cease to be wanted, it is yet, though within view, very distant; for it has only just entered upon its last function, to which old opinions and manners are still so opposed that the truth is not recognized, but hidden under pretences of imminent war, which is made the excuse of a great military apparatus provided, in fact, for service at home. That service will be better performed when it is avowed, and all false pretences are put away; and this might surely be done now that the central power itself is reduced to a similar provisional office. The military system and spirit are thus not doomed to the same decay as the sacerdotal, with which they were so long incorporated. The priesthood shows no disposition and no power to fuse itself in the new social organization; whereas there has never been a time since the decline of the military system began, when the soldiery were unable to assume the spirit and manners appropriate to their new social destination. In modern times the military mind has shown itself ready for theological emancipation; its habits of discipline is favorable to incorporation, and its employments to scientific researches and professional studies; all which are propitious to the positive spirit. In recent times, consequently, the spirit of the army has been, in France at least, strikingly progressive; while that of the priesthood has been so stationary as to place it actually outside of the modern social action. Thus different are now the character and the fate of the two elements of ancient civilization, which were once so closely connected. The one is now left behind in the march of social improvement, and the other is destined to be gradually absorbed.

Here I close my review of the negative progress of the last half-century; and I proceed to review the positive progression under the four heads into which it was divided in the preceding period.

Recent Industrial progress.

The Industrial evolution has gone on, as in natural course of prolongation from the preceding period. The revolutionary crisis assisted and confirmed the advance by completing the secular destruction of the ancient hierarchy, and raising to the first social rank, even to a degree of extravagance, the civic influence of wealth. Since the peace this process has gone on without interruption, and the technical progress of industry has kept pace with the social. I assigned the grand impetus of the movement to the time when mechanical forces were largely adopted in the place of human industry; and during the last half-century the systematic use of machinery, owing to the application of steam, has caused prodigious improvements in artificial locomotion, by land, river, and sea, to the great profit of industry. This progression has been caused by the union of science and industry, though the mental influence of this union has been unfavorable to the philosophy of science, for reasons which I shall explain. In recent times the industrial class, which is, by its superior generality, most capable of entertaining political views, has begun to show its capability, and to regulate its relations with the other branches, by means of the system of public credit which has grown out of the inevitable extension of the national expenditure. In this connection we must take note, unhappily, of the growing seriousness of the deficiencies which I pointed out at the end of the last chapter. Agricultural industry has been further isolated through the stimulus given to manufacturing and commercial industry, and their engrossing interest under such circumstances. A worse and wholly unquestionable mischief is the deeper hostility which has arisen between the interests of employers and employed,—a state of things which shows how far we are from that industrial organization which is illustrated by the very use of those mechanical agencies, without which the practical expansion of industry could not have taken place. There is no doubt that the dissension has been aggravated by the arts of demagogues and sophists, who have alienated the working class from their natural industrial leaders; but I can not but attribute this severance of the head and the hands much more to the political incapacity, the social indifference, and especially the blind selfishness of the employers than to the unreasonable demands of the employed. The employers have taken no pains to guard the workmen from seduction by the organization of a broad popular education, the extension of which, on the contrary, they appear to dread; and they have evidently yielded to the old tendency to take the place of the feudal chiefs, whose fall they longed for without inheriting their antique generosity toward inferiors. Unlike military superiors, who are bound to consider and protect their humblest brother-soldiers, the industrial employers abuse the power of capital to carry their points in opposition to the employed; and they have done so in defiance of equity, while the law authorized or countenanced coalitions among the one party, which it forbade to the other. Passing thus briefly over evils which are unquestionable, I must once more point out the pedantic blindness of that political economy which, in the presence of such conflicts, hides its organic helplessness under an irrational declaration of the necessity of delivering over modern industry to its unregulated course. The only consolation which hence arises is the vague but virtual admission of the insufficiency of popular measures, properly so called,—that is, of purely temporal resources,—for the solution of this vast difficulty, which can be disposed of by no means short of a true intellectual and moral reorganization.

Recent Æsthetic progress.

In Art, the main advance has been the exposure of the defect of philosophical principle and social destination, in modern Art, and of the hopelessness of imitation of antique types,—an exposure which has been brought about by the general direction of minds toward political speculation and regeneration as a whole. Amidst the wildness, the æsthetic vagabondism, to which the negative philosophy gave occasion and encouragement, especially in France,—taking the form for the substance, and discussion for construction, and interdicting to Art all large spontaneous exercise and sound general efficacy,—there have been immortal creations which have established in each department the undiminished vigor of the æsthetic faculties of mankind, even amidst the most unfavorable environment. The kind of Art in the form of literature which appears most suitable to modern civilization is that in which private is historically connected with public life, which in every age necessarily modifies its character. The Protestant civilization of times sufficiently remote and well chosen is represented, amidst the deep interest of all Europe, by the immortal author of "Ivanhoe," "Quentin Durward," "Old Mortality," and "Peveril of the Peak;" while the Catholic civilization is charmingly represented by the author of "I Promessi Sposi," who is one of the chief ornaments of Art in modern times. This epic form probably indicates the mode of renovation of Art generally, when our civilization shall have become solid, energetic, and settled enough to constitute the subject of æsthetic representation. The other fine arts have well sustained their power during this recent period, without having achieved any remarkable advancement, unless it be in the case of music, and especially dramatic music, the general character of which has risen, in Italy and Germany, to higher elevation and finish. A striking instance of the æsthetic power proper to every great social movement is afforded by the sudden production, in a nation so unmusical as the French, of the most perfect type of political music in the

Revolutionary hymn which was so animating to the patriotism of the citizen-soldiery of France.

Recent Scientific progress

The progress of Science was, at the same time, steady and effective, without any extraordinary brilliancy. On account of that progress, and of the supreme importance of science as the basis of social reorganization, and again, of the serious faults and errors invloved in its pursuit, we must look a little more closely into its condition during this recent period.

In mathematical science, besides the labors necessary for the completion of Celestial Mechanics, we have Fourier's great creation, extending analysis to a new order of general phenomena by the study of the abstract laws of the equilibrium and motion of temperatures. He also gave us, in regard to pure analysis, his original conception on the resolution of equations, carried forward, and in some collateral respects improved, by various geometers who have not duly acknowledged the source whence they derived the master idea. Geometry has been enlarged by Monge's conception of the general theory of the family of surfaces,—a view still unappreciated by ordinary mathematicians, and perhaps even by Monge himself, Lagrange alone appearing to have perceived its full bearings. Lagrange at the same time perfected Rational Mechanics as a whole, by giving it entire rationality and unity. This great feat must not however be considered by itself, but must be connected with Lagrange's effort to constitute a true mathematical philosophy, founded on a prior renovation of transcendental analysis, a purpose which is illustrated by that incomparable work in which he undertook to regenerate in the same spirit all the great conceptions, first of analysis, then of geometry, and finally of mechanics. Though this premature project could not be wholly successful, it will be, in the eyes of posterity, the pre-eminent honor of this mathematical period, even leaving out of the account the philosophical genius of Lagrange, the only geometer who has duly appreciated that ulterior alliance between the historical spirit and the scientific, which must signalize the highest perfection of positive speculation. Pure astronomy, or celestial geometry, must always advance in an inferior way, in comparison with celestial mechanics; but there have been some interesting discoveries,—as of Uranus, the small planets between Mars and Jupiter, and some others. In Physics, in the midst of some hypothetical extravagance, many valuable experimental ideas have arisen in all the principal departments, and especially in Optics and Electrology, by means of the successive labors of Malus, Fresnel, and Young, on the one hand, and of Volta, Oersted, and Ampère, on the other. We have seen how Chemistry has been advanced, in the midst of the necessary demolition of Lavoisier's beautiful theory, by the gradual formation of its numerical doctrine, and by the general series of electrical researches. But the great glory of the period in the eyes of future generations will be the creation of biological philosophy, which completes the positive character of the mental evolution, while it carries modern science forward to its highest social destination. I have said enough, in the earlier chapters, to show the importance of Bichat's conceptions of vital dualism, and especially of the theory of tissues; and of the successive labors of Vicq-d'Azyr, Lamarck, and the German school, to constitute the animal hierarchy, since rendered systematic by the philosophical genius of Blainville; and, finally, of the all-important discoveries of Gall, by which the whole of science, with the exception of social speculations, is withdrawn from the cognizance of the theologico-metaphysical philosophy. We ought not to overlook the important though premature attempt of Broussais to found a true pathological philosophy. His deficiency of materials and imperfect biological conceptions should not render us insensible to the merit and the utility of this great effort, which, after having excited an undue enthusiasm, has fallen into temporary neglect. The biological evolution has certainly contributed, more than any other part of the scientific movement, to the progress of the human mind, not only in a scientific view, by affording a basis for the philosophical study of Man, preparatory to that of Society, but far more in a logical view, by establishing that part of natural philosophy in which the synthetical spirit must finally prevail over the analytical, so as to develop the intellectual condition most necessary to sociological speculation. In this way, but without being suspected, the scientific movement was closely connected with the vast political crisis, through which social regeneration was sought before its true basis was ascertained.

Meantime, the scientific element was becoming more and more incorporated with the modern social system. In the midst of the fiercest political storms, scientific educational institutions were rising up, which were less devoted to specialities than they are now, though still too much so. Throughout civilized Europe there was a striking increase in the amount of scientific conditions imposed at the entrance on any of a multitude of professions and employments, by which means authorities who are most averse to reorganization are led to regard real knowledge more and more as a practical safeguard of social order. Among the special services of science to the time is the institution of an admirable system of universal measures, which was begun by revolutionary France, and thence slowly spread among other nations. This introduction of the true speculative spirit among the most familiar transactions of daily life is a fine example and suggestion of the improvements that must ensue whenever a generalized scientific influence shall have penetrated the elementary economy of society.

Abuses.

These are the favorable features of the scientific movement. The vicious tendencies have grown in an over-proportion, and consist of that abuse of special research which I have so often had occasion to denounce and lament. In all reforms, and in all progressions, the most vehement opposition arises from within. Hildebrand's enterprise of raising the Catholic clergy to be the head of society in Europe was counteracted by none so formidably as by the priesthood; and in like manner, it is the *savans* who now oppose, with violent prejudice and passion, the organization of science which alone can give it the social influence that it ought to be obtaining. It is not ambition that they want, but enlargement and elevation. The partial perfection of our positive knowledge may easily deceive both the public and the workers as to the real value of most of the contributors, each of whom has probably furnished an extremely minute and easy portion to the vast elaboration; and it is not always understood by the public that, owing to the extreme restriction of pursuit, any *savant* who may have won honor in some single inquiry, may not be above mediocrity in any view, even in connection with science. In the theological case, the clergy were superior to religion; in the scientific case, on the contrary, the doctors are inferior to the doctrine. The evil is owing to the undue protraction of a state of things inevitable and indispensable in its day.

We have seen that when modern science was detached from the scholastic philosophy, there was a provisional necessity for a system of scientific speciality; and that because the formation of the different sciences was successive, in proportion to the complexity of their phenomena, the positive spirit could in no way have elicited the attributes of each case but by a partial and exclusive institution of different orders of abstract speculation. But the very purpose of this introductory system indicated its transitory nature, by limiting its office to the interval preceding the incorporation of rational positivity with all the great elementary categories,—the boundary being thus fixed at the seventeenth and eighteenth centuries, as my survey has shown. The two great legislators of positive philosophy, Bacon and Descartes, saw how merely provisional was this ascendency of the analytical over the synthetical spirit: and under their influence the *savans* of those two centuries pursued their inquiries avowedly with the view of accumulating materials for the ultimate construction of a philosophical system, however imperfect their notion of such a system might be. If this spontaneous tendency had been duly grounded, the preparatory stage would have come to its natural close on the advent of biological science; and, during the last half-century, the discovery of the scientific place of the intellectual and moral faculties would have been received as completing the system of natural philosophy, up to the threshold of social science, and as constituting an order of speculation in which, from the nature of the phenomena, the spirit of generality must overrule the spirit of detail. But the habits of special pursuit were too strong to be withstood at the right point; and the preparatory stage has been extended to the most disastrous degree, and even erected into an absolute and indefinite state of affairs. It even appears as if the radical distinction were to be effaced between the analytical and the synthetical spirit, both of which are necessary in all positive speculation, and which should alternately guide the intellectual evolution, individual and social, under the exigencies proper to each age; the one seizing the differences and the other the resemblances: the one dividing, and the other co-ordinating; and therefore the one destined to the elaboration of materials, and the other to the construction of edifices. When the masons will endure no architects, they aim at changing the elementary economy of the human understanding. Through this protraction of the preparatory stage, the positive philosophy can not be really understood by any student, placed in any part of the present vicious organization of scientific labor. The *savans* of each section acquire only isolated fragments of knowledge, and have no means of comparing the general attributes of rational positivity exhibited by the various orders of phenomena, according to their natural arrangement. Each mind may be positive within the narrow limits of its special inquiry, while the slave of the ancient philosophy in all the rest. Each may exhibit the fatal contrast between the advancement of some partial conceptions, and the disgraceful triteness of all the rest: and this is the spectacle actually afforded by the learned academies of our day, by their very constitution. The characteristic parcelling out of these societies,—a reproduction of their intellectual dispersion,—increases the mischief of this state of things by facilitating the rise of ordinary minds, which are less likely to amend the scientific constitution than to be jealous of a philosophical superiority of which they feel themselves incapable. It is lamentable that, at a time when the state of human affairs offers every other encouragement to the active pursuit of generalities, science, in which alone the whole solution lies, should be so degraded by the incompetence of its interpreters as that it now seems to prescribe intellectual restriction, and to condemn every attempt at generalization. The demerit of the classes of *savans* implicated in the case varies in proportion to the independence and simplicity of the phenomena with which they are respectively engaged. The geometers are the most special and empirical of all; and the mischief began with them. We have seen how, though positivism arose in the mathematical province, the geometers see nothing before them but a future extension of their analysis to all phenomena whatever; and how the absolute character of the old philosophy is more thoroughly preserved among them than any other class, from their greater intellectual restriction. The biologists, on the contrary, whose speculations are necessarily dependent on all the rest of natural philosophy, and relating to a subject in which all artificial decomposition implies a spontaneous future combination, would be the least prone to dispersive errors, and the best disposed for philosophical order, if their education were in any agreement with their destination, and if they were not too apt to transfer to their own studies the conceptions and habits proper to inorganic research. Their influence is beneficial on the whole however, as counteracting, though too feebly, the ascendency of the geometers. Their progression has, accordingly, been more impeded than aided by the learned bodies, whose nature relates to a preparatory period when the inorganic philosophy, with its spirit and practice of detail, flourished alone. The Academy of Paris, for instance, which had no welcome for Bichat, and formed a junction with Bonaparte to persecute Gall, and failed to recognise the worth of Broussais, and admitted the brilliant but superficial Cuvier to a superiority over Lamarck and Blainville, has a much less complete and general sense of biological philosophy than prevails beyond its walls. These faults of the scientific class have become the more conspicuous from the new social importance that has been accorded to *savans* during the last half-century, and which has elicited at once their intellectual insufficiency and the moral inferiority which must attend it, since, in the speculative class, elevation of soul and generosity of feeling can hardly be developed without generality of ideas, through the natural affinity between narrow and desultory views and selfish dispositions. During a former period, when science began to be systematically encouraged, pensions were given to *savans* to enabled them freely to carry on their work; a mode of provision which was suitable to the circumstances of the time. Since the revolutionary crisis, the system has been changed in some countries, and especially in France, by conferring on learned men useful office and its remuneration, by which they are rendered more independent. No inquiry was made, however, as to the fitness of the *savans* for the change. Education was one chief function thus appointed; and thus we find education in special subjects more and more engrossed by learned bodies; and pupils sent forth who are less and less prepared to recognise the true position of science in relation to human welfare. The end of this provisional state of things is, however, manifestly approaching. When science itself is found to be injured by the inaccuracy of observations, and by its too selfish connection with profitable industrial operations, a change must soon take place: and no influence will then impede the renovation of modern science by a generalization which will bring it into harmony with the chief needs of our position. We may regard the *savans*, properly so called, as an equivocal class, destined to speedy elimination, inasmuch as they are intermediate between the engineers and the philosophers, uniting in an untenable way the speciality of occupation of the one, and the abstract speculative character of the other. Out of the academies themselves the greater number of the *savans* will melt in among the pure engineers, to form a body practically offering to direct the action of Man upon nature, on the principles specially required: while the most eminent of them will doubtless become the nucleus of a really philosophical class directly reserved to conduct the intellectual and moral regeneration of modern society, under the impulsion of a common positive doctrine. They will institute a general scientific education, which will rationally superintend all ulterior distribution of contemplative labors by determining the variable importance which, at each period, must be assigned to each abstract category, and therefore first granting the highest place to social studies, till the final reorganization shall be suffi ciently advanced. As for the *savans* who are fit for neither class, they will abide outside of any genuine classification, till they can assume some social character, speculative or active,—their special labors meantime being welcomed with all just appreciation; for those who are capable of generality can estimate the value of the special, while the understanding restricted to special pursuit can feel nothing but aversion for complete and therefore general conceptions. This fact easily explains the antipathy which these provisional leaders of our mental evolution entertain against all proposals and prophecies of true intellectual government, dreaded in proportion as its positivity renders it powerful against all usurpation.

Recent Philosophical progress.

Turning to the consideration of philosophy during the last half-century, we find its state no less lamentable than that of science. It might have been hoped that this element might have corrected the peculiar vice of the other, substituting the spirit of generality for that of speciality: but it has not been so. Instead of rebuking that vice, philosophy has given a dogmatic sanction to it by extending it to the class of subjects to which it is thoroughly repugnant. When science diverged from a worn-out philosophy in the sixteenth and seventeenth centuries, without being as yet able to furnish a basis for any other, philosophy, receding further and further from science, which it had before directed, restricted itself to the immediate formation of moral and social theories, which had no permanent relation to the only researches that could supply a true foundation, as to either method or doctrine. Since the separation took place, there has been in fact no philosopher, properly so called; no mind in which the spirit of generality has been habitually preponderant, what ever might be its direction,—theological, metaphysical, or positive. In this strict sense, Leibnitz might be called the last modern philosopher; since no one after him—not even the illustrious Kant, with all his logical power — has adequately fulfilled the conditions of philosophical generality, in agreement with the advanced state of intellectual progress. Except some bright exceptional presentiments of an approaching renovation, the last half-century has offered nothing better than a barren dogmatic sanction of the transitory state of things now existing. As however this vain attempt is the characteristic of what is called philosophy in our day, it is necessary to notice it.

We have seen that the general spirit of the primitive philosophy, which still lingers through time and change, chiefly consists in conceiving the study of Man, and especially intellectual and moral Man, as entirely independent of that of the external world, of which it is supposed to be the basis, in direct contrast with the true definitive philosophy. Since science has shown the marvellous power of the positive method, modern metaphysics has endeavored to make its own philosophy congenial with the existing state of the human mind by adopting a logical principle equivalent to that of science, whose conditions were less and less understood. This procedure, very marked from the time of Locke onward, has now issued in dogmatically sanctioning, under one form or another, the isolation and priority of morals peculation, by representing this supposed philosophy to be, like science itself, founded on a collection of observed facts. This has been done by proposing, as analogous to genuine observation, which must always be external to the observer, that celebrated *interior observation* which can be only a parody on the other, and according to which the ridiculous contradiction would take place, of our reason contemplating itself during the common course of its own acts. This is the doctrine which was learnedly prescribed at the very time that Gall was irreversibly incorporating the study of the cerebral functions with positive science. Every one knows what barren agitation has followed upon this false principle, and how the metaphysical philosophy of the present day puts forth the grandest pretensions, which produce nothing better than translations and commentaries on the old Greek or scholastic philosophy, destitute of even an historical estimate of the corresponding doctrines, for want of a sound theory of the evolution of the human mind. The parody at first implicated only the logical principle; but it soon comprehended the general course of the philosophy. The speciality which belongs to inorganic researches alone, was transferred to this just when it ought to have been allowed to disappear even in its own domain of science. A philosophy worthy of the name would at once have indicated to scientific men, and especially to biologists, the enormous error they were committing by extending to the science of living bodies, in which all aspects are closely interconnected, a mode of research that was only provisionally admissible even in regard to inert bodies. That instead of this, the so-called philosophy should have argued from the error of the other case, and have applied it systematically to the study which has always been admitted to require unity and generality above all others, appears to me one of the most memorable examples on record of a disastrous metaphysical infatuation. Such is the decayed condition of the philosophical evolution in the nineteenth century. But its very weakness is an evidence of the common sense of the need and the power of intellectual generality, since it is the affectation of that quality which provisionally sustains the practical influence of a doctrine now in universal disrepute, which has no other office than keeping up, in an imperfect way, a notion of intellectual concentration in the midst of the most active dispersion. When the advent of the true philosophy shall have stripped the metaphysical doctrine of every vestige of this attribute, the supposed philosophy will disappear,—probably without any discussion, or any other notice than a comparison of its uses with those of its successor. Then the great preparatory schism, organized by Aristotle and Plato, between natural and moral philosophy, will be dissolved. As modified by Descartes, it has now reached its last term, after having fulfilled its provisional office. The intellectual unity, vainly because prematurely sought by scholasticism, will now result, irrevocably, from the perpetual coincidence of philosophical science and scientific philosophy. The study of moral and social Man will obtain without opposition the due normal ascendency which belongs to it in the speculative system, because it is no longer hostile to the most simple and perfect contemplations, but is even based upon them and contributary to their use. However men may act in the presence of this change,—whether young thinkers adhere to the philosophy of egotism or join that of renovation; whether the *savans* will rise to philosophy, or philosophers will return to science; and however a narrow and self-interested majority may resist the change,—there will be a nucleus of eminent minds to form the new spiritual body (which may be in differently called scientific or philosophical), under the sway and guidance of an adequate general education.

Here ends my historical review of the last half-century, and with it, of the whole past of the human race: a survey which yields the conviction that the present time is that in which the philosophical renovation, so long prepared for and projected by Bacon and Descartes, must take place. Amidst some personal impediments, everything is essentially ready for the process. I have endeavored to show how clear it is, after the failure of all manner of vain attempts, that science is the only basis of a true philosophy; and that their union affords the only fulfilment of the conditions of order and of progress, by substituting a sustained and determinate movement for a vague and anarchical agitation. It is for the thoughtful to judge whether any fundamental theory of human evolution, illustrated by the history of human progress, contains the principle of this great solution. But, before I proceed to the philosophical conclusions derivable from the whole of this Work, I must offer a general elucidation of the new political philosophy which has been disclosed by the successive portions of my dynamical estimate, by specially and directly considering the proper nature of the spiritual reorganization in which we have seen the whole past converge, and from which the whole future must evidently proceed. The reader cannot fail to bear in mind the concatenation of events, as presented in my historical analysis; and he will not lose sight of my explanation that, though I was compelled, for the sake of clearness, to separate the negative from the positive progression of modern times, the two were in fact most intimately connected, and must be so considered in the act of drawing conclusions from them. It certainly appears to me that the whole course of human history affords so decisive a verification of my theory of evolution, that no essential law of natural philosophy is more fully demonstrated. From the earliest beginnings of civilization to the present state of the most advanced nations, this theory has explained, consistently and dispassionately, the character of all the great phases of humanity; the participation of each in the perdurable common development, and their precise filiation; so as to introduce perfect unity and rigorous continuity into this vast spectacle which other

The law of evolution.

wise appears desultory and confused. A law which fulfils such conditions must be regarded as no philosophical pastime, but as the abstract expression of the general reality. Being so, it may be employed with logical security to connect the past with the future, notwithstanding the perpetual variety which characterizes the social succession; for its essential course, without being in any way periodical, is thus constantly referrible to a steady rule which, almost imperceptible in the study of any separate phase, becomes unquestionable when the whole progression is surveyed. Now, the use of this great law has led us to determine the necessary general tendency of existing civilization by accurately marking the degree already achieved by the great evolution: and hence results at once the indication of the direction which the systematic movement should be made to take, in order to accord with the spontaneous movement. We have seen that the most advanced part of the human race has exhausted the theological and metaphysical life, and is now at the threshold of the fully positive life, the elements of which are all prepared, and only awaiting their co-ordination to form a new social system, more homogeneous and more stable than mankind has hitherto had any experience of. This co-ordination must be, from its nature, first intellectual, then moral, and finally political; for the revolution which has to be completed proceeds in fact from the necessary tendency of the human mind to substitute for the philosophical method which suited its infancy that which is appropriate to its maturity. In this view, the mere knowledge of the law of progression becomes the general principle of solution by establishing a perfect agreement in the whole system of our understanding, through the preponderance thus obtained, of the positive method, in social as in all other researches. Again, this last fulfilment of the intellectual evolution necessarily favors the ascendency of the spirit of generality, and therefore the sentiment of duty, which is, by its nature, closely connected with it, so as naturally to induce moral regeneration. Moral laws are at present dangerously shaken only through their implication with theological conceptions that have fallen into disrepute; and they will assume a surpassing vigor when they are connected with positive ideas that are generally relied on. Again, in a political view, the regeneration of social doctrine must, by its very action, raise up from the midst of anarchy, a new spiritual authority which, after having disciplined the human intellect and reconstructed morals, will peaceably become, throughout Western Europe, the basis of the final system of human society. Thus, the same philosophical conception which discloses to us the true nature of the great problem furnishes the general principle of the solution, and indicates the necessary course of action.

Speculative preparation.

In the present stage, the philosophical contemplation and labor are more important than political action, in regard to social regeneration; because a basis is the thing wanted, while there is no lack of political measures, more or less provisional, which preserve material order from invasion by the restless spirits that come forth during a season of anarchy. The governments are relying on corruption and on repressive force, while the philosophers are elaborating their principles; and what the philosophers have to expect from wise governments is that they will not interfere with the task while in progress, nor hereafter with the gradual application of its results. The French Convention is, thus far, the only government that, since the opening of the crisis, has manifested any instinct of its true position. During its ascending phase, at least, it strove, amidst vast difficulties, to introduce progressive though provisional institutions; whereas, all other political powers have written on their flimsy erections that they were built for eternity.

Spiritual authority.

As for the kind of persons who are to constitute the new spiritual authority,—it is easy to say who they will not be, and impossible to say who they will be. There will be no organization like that of the Catholic priesthood, for the benefit of any existing class. I need not say that it will not be the *savans*. It will not be any class now existing; because the natural elements of the new authority must undergo a thorough intellectual and moral regeneration in accordance with the doctrine which is to organize them. The future spiritual power will reside in a wholly new class, in no analogy with any now existing, and originally composed of members issuing, according to their qualifications, from all orders of existing society,—the scientific having, to all appearance, no sort of predominance over the rest. The advent of this body will be essentially spontaneous, since its social sway can arise from nothing else than the voluntary assent of men's minds to the new doctrines successively wrought out: and such an authority can therefore no more be decreed than it can be interdicted. As it must thus arise, little by little, out of its own work, all speculation about the ulterior forms of its constitution would be idle and uncertain. As its social power must, like that of Catholicism, precede its political organization, all that can be done now is to mark its destination in the final social system, so as to show how it may act on the general state of affairs, by accomplishing the philosophical labors which will secure its formation long before it can be regularly constituted.

I can not but suppose my readers convinced by this time that there is a growing pressure of necessity for a spiritual power entirely independent of the temporal,—governing opinions and morals, while the civil rule applies only to acts. We see that the grand characteristic of human progress is an ever-increasing preponderance of the speculative over the active life: and, though the latter always keeps the active ascendency, it would be contradictory to suppose that the contemplative part of Man is to be for ever deprived of due culture and distinct direction in the social state in which the reason will find habitual scope and expansion, even among the lowest order, while the separation existed, in the

Middle Ages, amidst a civilization which stood much nearer to the cradle of human society. All the wise now admit the necessity of a permanent division between theory and practice, in order to the perfecting of both; even in regard to the smallest subjects of study: and there can be no more hesitation about applying the principle to operations of the utmost difficulty and importance, when we are advanced enough for the process. Intellectually, the separation of the two powers is merely the external manifestation of the same distinction between science and art, transferred to social ideas, and there systemized. It would be a vast retrogression, most degrading to our intelligence, if we were to leave modern society below the level of that of the Middle Ages, by reconstituting the ancient confusion which the Middle Ages had outgrown, without any of the excuse that the ancients had for that confusion. Yet more striking would be the return to barbarism in the moral relation. We have seen how, by the aid of Catholicism, Morality escaped from the control of policy, to assume the social supremacy which is its due, and without which it could not attain a necessary purity and universality. This procedure, so little understood by the philosophic vulgar, laid the foundation of our moral education by securing from the encroachment of inferior and private interests the immutable laws which relate to the most intimate and general needs of the human race. It is certain that this indispensable co-ordination would have no consistence amidst the conflict of human passions if, resting only on an abstract doctrine, it was not animated and confirmed by the intervention of a moral power distinct from, and independent of, the political. We know this by what we see of the breaches of morals that take place through the spiritual disorganization, and though the morality which accords with modern civilization is thereby secured from dogmatic attack,—fallen as is the Catholic philosophy, which was its original organ. We may observe in our metaphysical constitutions themselves some recognition of the principle of separation in those remarkable preliminary declarations which give to the humblest citizens a general control of political measures. This is a feeble image and imperfect equivalent of the strong means furnished by the Catholic organism to every member for resistance to every legal injunction which should be contrary to established morality,—avoiding, the while, any revolt against an economy regularly founded on such a separation. Since Mankind first really entered upon a career of civilization, this great division has been, in all respects, the social principle of intellectual elevation and moral dignity.—It fell into discredit, it is true, with the decline of Catholicism; but revolutionary prejudices are not to last for ever; and the nature of modern civilization both prescribes and prepares for a renewal of the distinction, without any of the forced character which belonged to it in the Middle Ages. Under the ascendency of Industry, there can be no confusion between the speculative and the active authorities, which could never be united in the same organ, for the simplest and most restricted operations; and much less for those of high social importance. Morals and manners are as adverse to such a concentration as capacities. Though the different classes imitate one another too much, and though wealth is held in pre-eminent honor at present, no one will pretend that riches can confer any right to decide on great social questions. Again, while artists, and, more disgracefully, scientific men, struggle in rivalship of wealth with industrial leaders, there is no reason to fear that the æsthetic and the scientific career can never lead to high station by means of wealth. The generous improvidence of the one order of men, when their vocation is real, is incompatible with the anxious solicitude necessary to the acquisition of wealth. The highest degrees of fortune and of consideration can never be united; the first belonging naturally to services of immediate and material utility; and the other following, more remotely, upon speculative labors, which, in proportion to their superior social value, find at length their social reward in the highest veneration. There is some recognition of the necessity of a separate spiritual government in the influence which actually belongs to men of letters and metaphysicians in our day; and the only real question is whether society shall be governed on a basis of ascertained knowledge and unquestionable philosophy, or whether it shall be guided by organs qualified neither by sound knowledge nor by genuine conviction. The answer is found in the fact that, whereas in the Middle Ages the separation of powers was necessarily as imperfect as it was arbitrary, the tendency of the modern social spirit is to render human government more and more moral and less and less political. The moral reorganization is the most urgent; and it is at the same time the best prepared. The governments decline it more and more, and thus leave it for the hands that ought to assume it: and the peoples have had experience enough to convince them that existing principles of government have done all that is to be expected of them, and that social progress must depend upon a wholly new philosophy.

We have seen how the Greek philosophers dreamed of a political reign of Mind, and how dangerous and futile such a notion was. During the Middle Ages the Catholic system provided satisfaction for intellectual ambition: but when, by the demolition of that system, the two orders of power were again confounded, the old Utopia was revived. Except the few whom their philosophy raised above such desires, almost all active minds have been actuated, often unconsciously, by an insurrectionary tendency against a state of affairs which offered them no legal position. As the negative movement proceeded, such men grew more eager for temporal greatness, which was then the only social eminence; and during the revolutionary convulsion, such aspirations exceeded all bounds. Such attempts, unsupported by any religious organization, must necessarily succumb to the power of wealth, which had established a material preponderance too strong to be shaken; but the efforts themselves were very disturbing to the state of things which they could not essentially change. This principle of disorder is the more dangerous from its appearance of reasonableness. It is all that the most eminent rationality and morality combined can do to preserve a mind of the present day from the illusion that, as modern civilization tends to strengthen the social influence of intelligence, the government of society, speculative and active, ought to be confided to the highest intellectual capacity. Most minds that are occupied with social questions are secretly swayed by this notion,—without excepting those who repel the error which no one attempts rationally to vindicate. The separation of the two powers will extinguish this cause of disorder by providing for the gratification of whatever is legitimate in this ambition. The sound theory of the case, as imperfectly presented in the Middle Age system, is, that it is the social function of Mind to struggle perpetually, in its own way, to modify the necessary rule of material power, by subjecting it more and more to respect for the moral laws of universal harmony, from which all practical activity, public and private, is apt to revolt, for want of loftiness of view and generosity of sentiment. Regarded in this way, legitimate social supremacy belongs neither to force nor to reason, but to morality, governing alike the actions of the one and the counsels of the other. Such, at least, is the type which is to be proposed, though it may never be fully realized: and in view of it, Mind may sincerely relinquish its idle pretension to govern the world by the supposed right of capacity; for it will be regularly installed in a noble permanent office, alike adapted to occupy its activity and recompense its services. This spiritual authority will be naturally kept within bounds by the very nature of its functions, which will be those of education, and the consultative influence which results from it in active life; and again, by the conditions imposed on their exercise, and the continuous resistance which must be encountered,— the authority itself being founded on free assent, within the limits necessary to guard against abuse. Such an organization is the only issue for the disturbing political action of intelligence, which can escape from unjust exclusion only by aspiring to a vicious domination: and statesmen at present protract the embarrassment caused by the political claims of capacity by their blind antipathy to the regular separation of the two powers.—The system needed would be no less beneficial to the multitude than to the active few. The disposition to seek in political institutions the solution of all difficulties whatever is a disastrous tendency of our time. Naturally arising from the concentration of powers, it has been aggravated by the constitution-making of the last half-century. The hallucination will be dissolved by the same philosophical instigation which will destroy that of a reign of Mind. While a social issue is provided for a large mental capacity, just popular claims, which are oftener moral than political, will receive the guidance fittest for their object. There can be no doubt that the legitimate complaints odged by the masses against a system under which their general needs are too little considered, relate to a renovation of opinions and manners, and could not be satisfied by express institutions. This is especially true in regard to the evils inherent in the inequality of wealth, which afford the most dangerous theme to both agitators and dreamers; for these evils derive their force much more from our intellectual and moral disorder than from the imperfections of political measures. The philosophical expansion which is to work out the new system must, in this and in many other respects, exert a very important rational influence on modern populations,—directly facilitating the restoration of general and durable harmony; always supposing that it is linked with conditions of progress, no less than of order, and that, while showing that our social embarrassments are independent of institutions, the new instruction shall teach us the true solution,—the submission of all classes to the moral requirements of their position, under the instigation of a spiritual authority strong enough to enforce discipline. Thus might disturbing popular dispositions, now the constant source of political illusion and quackery, be reformed; and the vague and stormy discussion of *rights* would be replaced by the calm and precise determinations of *duties*. The one, a critical and metaphysical notion, necessarily prevailed till the negative progression was completed: the other, essentially an organic and positive idea, must rule the final regeneration: for the one is purely individual, and the other directly social. Instead of making individual duty consist politically in respect for universal rights, the rights of each individual will be regarded as resulting from the duties of others toward him: in the one case the morality will be nearly passive, and will be ruled by selfishness: whereas in the other the morality will be thoroughly active, and directed by benevolence. Here, again, the opposition of statesmen is wholly inconsistent with their own complaints of the eagerness of the popular mind for political solutions of their difficulties:—the difficulties exist; the popular tendency exists; and no complaints of either can avail while politicians themselves discountenance the only means of correcting the thoughtless popular habit and desire.

Such are the services to be rendered by the new spiritual authority. In order to dispel the natural uneasiness excited by the mention of such an agency in our day, connected as it is in most minds with theocratic notions, I will briefly indicate its offices and prerogatives, and the consequent nature of its normal authority.

Its Educational function.

If we resort to the Catholic organization as to a sort of pattern of spiritual government, we must remember that we have now nothing to do with the religious element; and we must consider the clergy in their social relations alone. Being careful to do this, we may refer to my statement of their function, as being that of every spiritual authority;—that of directing Education, while remaining merely consultative in all that relates to Action,—having, in fact, no other concern with action than that of recalling in each case the appropriate rules of conduct. The temporal authority, on the other hand, is supreme in regard to Action, and only consultative in regard to Education. Thus the great characteristic office and privilege of the modern spiritual power will be the organization and working of a universal system of positive Education, not only intellectual, but also, and more emphatically, moral. In order to maintain the positive nature and social purpose of this education, it must be ever remembered that it is intended for the direct and continuous use of no exclusive class, however vast, but for the whole mass of the population of Western Europe. Catholicism established a universal education, imperfect and variable, but essentially homogeneous, and common to the loftiest and the humblest Christians: and it would be strange to propose a less general institution for a more advanced civilization. The revolutionary demand for equality in education manifested a sense of what was needed, and a forecast of what was coming. In our own time no feature of the existing anarchy is more disgraceful than the indifference of the upper classes about that absence of popular education which threatens them with a fearful retribution. The positive philosophy teaches us the invariable homogeneousness of the human mind, not only among various social ranks, but as regards individuals: and it therefore shows us that no differences are possible but those of degree. The system must be necessarily identical, but applied according to diversities of aptitude and of leisure. This was the principle and mode of the Catholic religious education: and it is now found to be the only sound one in the one kind of education that is regulated among us,—special instruction. Round this fundamental system will ramify spontaneously the various collateral pursuits which relate to direct preparation for different social conditions. The scientific spirit must then lose its present tendency to speciality, and be impelled toward a logical generality; for all the branches of natural philosophy must furnish their contingent to the common doctrine; in order to which they must first be completely condensed and co-ordinated. When the *savans* have learned that active life requires the habitual and simultaneous use of the various positive ideas that each of them isolates from all the rest, they will perceive that their social ascendency supposes the prior generalization of their common conceptions, and consequently the entire philosophical reformation of their present practice. Even in the most advanced sciences, as we have seen, the scientific character at present fluctuates between the abstract expansion and the partial application, so as to be usually neither thoroughly speculative nor completely active; a consequence of the same defect of generality which rests the ultimate utility of the positive spirit on minor services, which are as special as the corresponding theoretical habits. But this view, which ought to have been long outgrown, is a mere hinderance in the way of the true conception,—that positive philosophy contemplates no other immediate application than the intellectual and moral direction of civilized society; a necessary application, presenting nothing that is incidental or desultory, and imparting the utmost generality, elevation, unity, and consistency, to the speculative character. Under such a homogeneousness of view and identity of aim, the various positive philosophers will naturally and gradually constitute a European body, in which the dissensions that now break up the scientific world into coteries will merge; and with the rivalries of struggling interests will cease the quarrels and coalitions which are the approbrium of science in our day.

Regeneration of morality.

Under this system of general education, Morality will be immoveably based upon positive philosophy as a whole. Human nature being one of the branches of positive knowledge, it will be understood how childhood is to be trained in good habits, by means of the best prepossessions; and how those habits and views are afterward to be rationalized, so as solidly to establish the universal obligations of civilized Man,—duties personal, domestic, and social, with the modifications that will be required by changes in civilization. We have seen how all connection between theological faith and morality has long been recognised as arbitrary; and any such degree of theological unity as is necessary for affording a basis to morality, would now suppose a vast system of hypocrisy, which, if it were possible, would be fatal to the very morality it proposed to sustain. In the present state of the most advanced portion of the human race, the positive spirit is certainly the only one which, duly systemized, can at once generate universal moral convictions and permit the rise of a spiritual authority independent enough to regulate its social application. At the same time, the social sentiment, as a part of morals, can be fully developed only by the positive philosophy, because it alone contemplates and understands the whole of human nature. The social sentiment has hitherto been cultivated only in an indirect and even contradictory manner, under the theological philosophy first, which gave a character of exorbitant selfishness to all moral acts; and then under the metaphysical, which bases morality on self-interest. Human faculties, affective as well as intellectual, can be developed only by habitual exercise; and positive morality, which teaches the habitual practice of goodness without any other certain recompense than internal satisfaction, must be much more favorable to the growth of the benevolent affections than any doctrine which attaches devotedness itself to personal considerations,—the admission of which allows no fair play to the claims of our generous instincts. It will be long before habit, sustained by powerful interests, will permit the systemizing of morality without religious intervention; and when it is done, it will be by the fulfilment itself silencing all controversy: and this is why no other part of the great philosophical task can be nearly so important in determining the regeneration of modern society. Humanity must be regarded as still in a state of infancy while its laws of conduct are derived from extraordinary fictions, and not from a wise estimate of its own nature and condition.

International duty.

I must point out another respect in which this great task will satisfy a serious present exigency. We have seen how the revolutionary influence extended, as the Roman sway once did, and the Catholic and feudal system afterward, over the whole of Western Europe; whereas, the metaphysical polity does not look beyond national action, in which the community of nations is wholly lost sight of. It can not be otherwise while the temporal government is supposed to include the spiritual; for the temporal union of nations is impossible but through mere oppression by the strongest. The five great nations concerned can not be for a moment supposed to be fused, or subjected to the same political government; and yet the perpetual extension of their mutual relations already requires the natural intervention of a moral authority which should be common to all, according to their aggregate affinities. This is now, as in the Middle Ages, the privilege of the spiritual power, which will connect the various populations by an identical educational basis, and thus obtain a regular, free, and unanimous assent. Such an education must have a European character; because Western Europe alone is qualified to receive it. It may hereafter be extended, even beyond the white races, as the outlying groups of humanity become fitted to enter the system; but, while asserting the radical identity of human nature everywhere, the new social philosophy must distinguish between positive societies and those which are still theological or metaphysical; in the same way that the Middle Age system distinguished Catholic populations from those which were polytheistic or fetich. The only difference between the two cases is that the modern organization is destined to a wider spread, and that there is a superior reconciling quality in a doctrine which connects all human situations with the same fundamental evolution. The necessity of extending the modern regeneration to Western Europe in general teaches us how the temporal reorganization proper to each nation, must be preceded and directed by a spiritual reorganization common to them all: and at the same time, the philosophical constitution of positive education provides the best instrumentality for satisfying the social need of union by summoning all nationalities to the same task, under the direction of a homogeneous speculative class, habitually animated by an active European patriotism. The same power which administers education watches over the application, through life, of the principles taught: thus, this eminent authority, impartial in its nature, and planted at the general point of view, will naturally be the arbitrating power among the nations that it will have trained. International relations can not be submitted to any temporal authority; and they would be at the mercy of mere antagonism if they did not fall under the natural decision of the only general authority. Hence must arise an entirely new diplomatic system; or rather, the closing of an interregnum instituted by diplomacy to facilitate the great European transition,—as I have already explained. The great wars are no doubt over; but the divergences which arise the more as relations extend will find new forms, less disastrous, but equally requiring the intervention of a moderating power. The selfish interests which, for example, are brought into collision by the extension of Industry, may be best kept in check by an authority which assigns its true value to the practical point of view, which directs the moral education of nations, as well as of individuals and classes, and which must therefore be best fitted to bring the divergences of practical life into subordination to a higher order of power.

Basis of Assent

The difference of social character between this authority and the Catholic sway is easily pointed out, and important to be understood. All spiritual authority must rest on free and perfect confidence and assent, such as are accorded to intellectual and moral superiority; and they imply an agreement and sympathy in a common primary doctrine, regulating the exercise and the conditions of the relation, which is dissolved when the doctrine is disbelieved. The theological faith was connected with some revelation in which the believer had no share; and it must therefore be wholly different from the positive faith which follows upon demonstration, open to universal examination, under due conditions. Thus, the positive authority is essentially relative, like the spirit of the corresponding philosophy: and as no individual can know everything, and judge of everything, the confidence enjoyed by the most eminent thinker is analogous to that which, in a limited degree, he accords in turn to the humblest intelligence, on certain subjects best understood by the latter. The absolute power of man over man, which was so dreadful and irresistible in former ages, is gone for ever, together with the mental condition which gave rise to it: but, though the positive faith can never be so intense as the theological, its unsystematic action during the last three centuries proves that it can spontaneously occasion a sufficient agreement on subjects that have been duly explored. We see, by the universal admission of the chief scientific truths, notwithstanding their opposition to religious notions, how irresistible will be the sway of the logical force of genuine demonstration when human reason attains maturity; and especially when its extension to moral and social considerations shall have imparted to it its full energy. There will be a sufficient harmony between the need and the power of a regular discipline of minds,—at all events, when the theologico-metaphysical system, with all its disturbing influences, has died out. These considerations may serve to dissipate the theocratic uneasiness that naturally arises on the mere mention of any spiritual reorganization,—the philosophical nature of the new government wholly precluding such usurpations as those which were perpetrated by theological authority. Nevertheless, we must not suppose, on the other hand, that the positive system will admit of no abuses. The infirmity of our mental and moral nature will remain; and the social superintendence which will be natural will be also needful. We have only too much reason to know that true science is compatible with charlatanism, and that *savans* are quite as much disposed to oppression as the priests ever were, though happily they have not the same means and opportunity. The remedy lies in the critical social spirit, which was introduced with the Catholic system, and which must attend again upon the separation of the two powers. Its disastrous exaggeration in our day is no evidence against its future efficacy, when it shall have been duly subordinated to the organic spirit, and applied to restrain the abuses of the new system. The universal propagation of sound knowledge will check false pretension to a great extent: but there will also be need of the social criticism which will arise from the very constitution of the spiritual authority,—based as it must be on principles which may be at all times appealed to, as tests of capacity and morality. If, under the Catholic constitution, the meanest disciple might remonstrate against any authority, spiritual or temporal, which had infringed ordinary obligations, much more must such a liberty exist under the positive system, which excludes no subject whatever from discussion, under fitting conditions,—to say nothing of the greater precision and indisputableness of moral prescriptions under the positive system.

The Temporal authority.

I have exhibited the nature and character of the spiritual reorganization which must result from the preparation of past ages. It is not possible to perform the same office in regard to the temporal system, because it must issue from the other; and it is impossible for any one to foresee more than the general principle and spirit which will regulate the classification of society. Of that principle and spirit I may briefly speak; but it would be countenancing the empiricism of the present day to enter into detail, which must be altogether premature. First, we must discard the distinction between public and private functions,—a distinction which could never be more than temporary, and which it is impossible to refer to any rational principle. The separation was never contemplated till the industrial system succeeded to that of personal bondage: and then the distinction referred to the old system, on the one hand, with its normal functions; and, on the other, to the new system, with its partial and empirical operations, which were not perceived to have any tendency toward a new economy. Thenceforward the conception represents our view of the whole past, in its negative and its positive progression; and it assumed its present preponderance when the final crisis began, when public professions, spiritual and temporal, dissolved, as an extension took place of functions which were formerly private. The distinction will endure till the primary conception of the new system shall have taught all men that there is a public utility in the humblest office of co-operation, no less truly than in the loftiest function of government. Other men would feel, if their labor were but systemized, as the private soldier feels in the discharge of his humblest duty, the dignity of public service, and the honor of a share in the action of the general economy. Thus, the abolition of this distinction depends on the universal regeneration of modern

Public and private functions.

ideas and manners. We have thus to discard altogether the notion of private functions, as belonging to a transitory system, and to consider all as alike social, after having put out of the question whatever functions have to be eliminated; that is, the theological and metaphysical offices which will then have expired. The modern economy thus presenting only homogeneous elements, it becomes possible to form a conception of the classification that is to ensue. The elevation of private professions to the dignity of public functions need occasion no essential change in the manner of their discharge; but it will make all the difference in the world in their general spirit, and not a little in their ordinary conditions. While on the one hand there will be a universal personal sense of social value, there will be on the other hand an admission of the necessity of systematic discipline, incompatible with a private career, but guarantying the obligations belonging to each function. This one change will be a universal symptom of modern regeneration.

Principle of co-ordination.

The co-ordinating principle must be the same that I have applied in establishing the hierarchy of the sciences,—that of the degree of generality and simplicity of the subject, according to the nature of the phenomena. The same principle was tested in its application in the interior of each science; and when we were applying it in biology, we found it assuming a more active character, indicating its social destination. Transferred from ideas and phenomena to actual beings, it became the principle of zoological classification. We then found it to be the basis of social statics; and our dynamical inquiry showed us that it has determined all the elementary evolutions of modern social practice. It must thus be regarded as the law of all hierarchies; and its successive coincidences are explained by the necessary universality of logical laws. It will always be found working identically in every system which consists of homogeneous elements, subjecting all orders of activity to their due classification, according to their respective degrees of abstractness and generality. This was the principle of classification in old societies; and we see vestiges of it yet in the military organization, where the very terms of office indicate that the less general are subordinated to the more general functions. It needs no proof then, that, in a regenerated society, homogeneous in its elements, the change that will take place will be found to be in the elements, and not in their classification; for such classification as has taken place during the modern transition has been all in accordance with the principle. The only difficulty therefore lies in estimating the degrees of generality inherent in the various functions of the positive organism: and this very task has been almost entirely accomplished at the beginning of the last chapter, while the rest of the necessary material is furnished by the preceding part of the Work; so that I have only to combine these different particulars to create a rational conception of the final economy.

The idea of social subordination is common to the old and the new philosophy, opposite as are their points of view, and transitory as is the one view in comparison with the other. The old philosophy, explaining everything by the human type, saw everywhere a hierarchy regulated in imitation of the social classification. The new philosophy, studying Man in connection with the universe at large, finds this classification to be simply a protraction of the biological hierarchy. But science and theology, considering Man each in its own way,—the one as the first of animals, and the other as the lowest of angels,—lead to a very similar conclusion. The office of positive philosophy in this case is to substantiate the common notion of social subordination by connecting it with the principle which forms all hierarchies.

Speculative classes highest.

The highest rank is held, according to that principle, by the speculative class. When the separation of the two powers first took place under monotheism, the legal superiority of the clergy to all other orders was by no means owing only or chiefly to their religious character. It was more on account of their speculative character; and the continued growth of the tendency, amidst the decay of religious influences, shows that it is more disinterested than is commonly supposed, and testifies to the disposition of human reason to place the highest value on the most general conceptions. When the speculative class shall have overcome its dispersive tendencies, and returned to unity of principle amidst its diversity of employments, it will obtain the eminent position for which it is destined, and of which its present situation can scarcely afford any idea. While the speculative class is thus superior in dignity the active class will be superior in express and immediate power, the division answering to the two opposite ways of classifying men, by capacity and by power. The same principle determines the next subdivision of each class before pointed out in another connection. The speculative class divides itself, according to the direction taken by the contemplative spirit, into the scientific or philosophical (which we know to be ultimately one), and the æsthetic or poetic. Alike as these two classes are in their distinction from the active, they so differ from each other as to require division on the same principle as runs throughout. Whatever may be the ultimate importance and eminent function of the fine arts, the æsthetic point of view can never compare in generality and abstractness with the scientific or philosophical. The one is concerned with the fundamental conceptions which must direct the universal action of human reason; whereas the other is concerned only with the faculties of expression, which must ever hold a secondary place. As for the other leading class, the active or practical, which comprehends the vast majority, its more complete and marked development has already settled the point of its divisions; so that, in regard to them, the theory has only to rationalize the distinctions sanctioned by spontaneous usage. Industrial action is divided into production and transmission of products; the second of which is obviously superior to the first in regard to the abstractness of the work and the generality of the relations. Further divis-

The Practical classes.

ion seems to be indicated according as production relates to the mere formation of materials or their working up; and as the transmission is of the products themselves, or of their representative signs, the generality being greater in the second particulars than in the first. Thus we find the industrial hierarchy formed, the bankers being in the first rank; then the merchants; then the manufacturers; and finally the agriculturists; the labors of the latter being more concrete, and their relations more special, than those of the other three classes. It would be out of place to proceed here to further subdivisions. They will be determined by the same principle when the progress of reorganization is sufficiently advanced; and I may observe that when that time comes the most concrete producers, the laborers, whose collisions with their employers are now the most dangerous feature of our industrial state, will be convinced that the position of the capitalist is owing, not to any abuse of strength or wealth, but to the more abstract and general character of his function. The action and responsibility of the operative are less extensive than those of the employer; and the subordination of the one to the other is therefore as little arbitrary and mutable as any other social gradation.

Privileges and compensations.

When the gradation is once established, it will be preserved from question and confusion, not only by the clearness of its principle, but by the consciousness in each order that its own subordination to the one above it is the condition of its superiority to those below it; and the lowest of all is not without its own special privileges. The abuses attending all inequality will be restrained, not only by the fundamental education common to all, but by the more extended and severe moral obligations which press upon members of society, in proportion to the generality of their functions. Again, in proportion as social occupations are particular and concrete, their utility is direct, incontestable, and assured, and the existence of the workers is more independent, and their responsibility more restricted,—corresponding as their labors do to the most indispensable wants. Thus, if the higher ranks are dignified by a more eminent and difficult co-operation, the lower have a more certain and urgent function: and the last could provisionally exist by themselves, without perverting their essential character; whereas the others could not. This difference is not only a guarantee of social harmony, but it is favorable to private happiness, which, when the primary wants are securely provided for, depends mainly on the small amount of habitual solicitude: and thus, the lowest classes really are privileged in that freedom from care, and that thoughtlessness, which would be a serious fault in the higher classes, but are natural to them.

If we consider the successive degrees of material importance, as tested by wealth, we find an apparent contradiction in our statical series, between the speculative and the practical order: for in the first, the preponderance lessens as we ascend the scale, while in the latter it increases. This is owing to a distinction too little attended to by the economists,—between the more general extension and the more direct utility of any public services. Concrete labors, which prove to all eyes their own immediate use, are sure of a special recompense in proportion to their extension: but when the service is highly abstract, admitting of only an indirect appreciation, remote and dim, it is incontestable that, whatever may be its final utility, extensive in proportion to its generality, it will bring in less wealth, through the insufficient private estimation of a class whose partial influence admits of no ordinary analysis. Hence the dangerous error of measuring social participation by wealth, without distinction of the two orders, the speculative and the active,—thus extending to the first the law which relates only to the second. For instance, if the final results, even industrial only, of the great astronomical discoveries which have improved navigation could be estimated in each expedition, it is evident that no existing fortune could give any idea of the enormous wealth which would be realized by the heirs of the Keplers and the Newtons of society,—be the toll fixed as low as possible. Such a case shows the absurdity of the principle of pecuniary remuneration for all genuine services, by proving that the most extended utility must, on account of the remoteness and diffusion that belong to its generality, find its reward, not in wealth, but in social honor. Even in the speculative class, the same distinction is evident,—the æsthetic order being more in the way of wealth than the scientific,—inferior as their ultimate utility must be,—because they are more easily and immediately appreciated. Yet, in the face of these facts, there are economists who propose that the most abstract labors should be left to the protection of private interest. On the whole, it is clear that the greatest deposite of wealth will be in the middle of the hierarchy, with the banking class, who naturally head the industrial movement, and whose ordinary operations are at once appreciable and sufficiently general to favor the accumulation of capital. These circumstances, at the same time can not but render them more worthy of their temporal importance,—whenever, at least, their education shall be appropriate to their function. Their familiarity with abstract and extended enterprises must foster the spirit of generality, and an unusual aptitude for social combinations; so that with them will the temporal power principally rest. It will be remembered that this class will always be the least numerous in the industrial order; for the hierarchy will constantly exhibit growing numbers, in proportion as work becomes more particular and urgent, and therefore admits and requires more multiplied agents.

Practical privacy.

What I have said of the public character of all social offices under the new organization relates only to their social aspect, and not at all to the mode of their fulfilment. In fact, the more the individual is improved by education, the more freely may the execution of public operations be confided to private industry. The less general and more actual labors,—those which belong to the practical order,—may be safely delivered over to the natural action of individual minds; and, while the prerogative of the central authority is carefully preserved, there will be entire freedom from any regulating spirit which could impede spontaneous activity, on which progression directly depends. In the speculative case, however, the social efficacy is too indirect, too remote, and therefore too little felt by the multitude to depend altogether on private estimation for aid: and public munificence should protect labors of this kind, the political character of these functions becoming manifest, in proportion as they are more general and abstract. This is the only way in which there can be any distinction between public and private professions; and the distinction will not affect the idea of a common social destination.

Practical freedom.

It can hardly be necessary to point out that there will be perfect freedom in the formation of the respective classes of the positive hierarchy. The direct effect of a universal education is to place every one in the situation best adapted to his abilities, whatever his birth may have been. This is a liberty which depends more on general manners than on political institutions; and it depends upon two conditions,—that access to every social career should remain open to the capable; and that there should be some means of excluding the unworthy. When order is once completely established, such changes will become exceptional; because it is natural for professions to be hereditary. Few have a determinate vocation, and few social employments require such a vocation; so that the disposition to domestic imitation will have its way; whereas, the quality of the universal education and the state of social manners will be safeguards against this hereditary tendency assuming any oppressive form. There is no room for apprehension of any restoration of the system of castes. Caste can have none but a theological foundation; and we have long passed out of the last social phase that is compatible with it; and its remaining traces are, as I have shown, fast disappearing from amidst the advanced civilization of Western Europe.

It remains for me to point out the connection between such an organization and the just claims of the lower classes: and for this purpose I must ascertain the influence of such a connection, both upon the mass of the people and upon the speculative class.

Popular claims.

Any spiritual power must be, by its very nature, popular; for its function is to set up morality to guide the social movement, and its closest relations therefore must be with the most numerous classes, who most need its protection. The Catholic Church was obviously doomed to decay when it forsook its task of enlightening and protecting the people, and inclined to aristocratic interests: and in the same way, the inherent nullity of Protestantism appeared in the impotence of its puny authorities to protect the lower classes: and in the same way again, we recognise the empiricism and selfishness which spoil the speculative elements of our modern society in the strange aristocratic tendencies of so many *savans* and artists, who forget their own humble origin, and disdain to apply to the instruction and protection of the people the influence they have acquired,—preferring indeed to use it in confirmation of their own oppressive pretensions. There must be, in the normal state of the final economy, a strong sympathy between the speculative class and the multitude, from their analogous relation to the possessors of the chief temporal power, from their somewhat similar practical situation, and from their equivalent habits of material improvidence. Yet more important is the popular efficacy of the speculative authority, on account both of its educational function and of its regular intervention as moderator in social conflicts, through its habitual elevation of views and generosity of disposition. Without at all quitting its attitude of impartiality, its chief care will always be directed toward the humbler classes, who, on the one hand, are much the most in need of a public education such as their private means can not attain; and, on the other hand, are much more exposed to constant injury. Even now, vast benefit would ensue if, in preparation for the system to come, positive knowledge and philosophy were sedulously brought within reach of the people. In the educational direction, the intellectual expansion would be much greater than is now easily believed: and the advantage in the other respect, in protecting them from collision with the governing classes, would be no less evident. The positive philosophy would teach them the real value of the political institutions from which they are apt to hope so much, and convince them of the superiority of moral over political solutions. All evils and all pretexts derived from social disturbance would thus be obviated: quacks and dreamers would lose their vocation; and no excuse would be left for delay in social reform. When it is seen why wealth must chiefly abound among the industrial leaders, the positive philosophy will show that it is of small importance to popular interests in what hands capital is deposited, if its employment is duly useful to society at large: and that condition depends much more on moral than on political methods. No jealous legal provision against the selfish use of wealth, and no mischievous intervention, paralyzing social activity by political prohibition, can be nearly so effectual as general reprobation, grounded on an ascertained principle, under the reign of positive morality. The new philosophical action would either obviate or repress all the dangers which attend the institution of property, and correct popular tendencies by a wise analysis of social difficulties, and a salutary conversion of questions of right into questions of duty.—In its impartiality it will make the superior classes participate in the lesson, proving to them the great moral obligations inherent in their position; so that, for instance, in this matter of property, the rich will morally consider themselves the depositories of the wealth of society, the use of which will not involve any political responsibility (except in extreme cases), but should lie under a moral supervision, necessarily open to all, from the indisputableness of its principle, and of which the spiritual authority is the natural organ.

Since the abolition of personal servitude, the lowest class has never been really incorporated with the social system; the power of capital, once a means of emancipation, and then of independence, has become exorbitant in daily transactions, however just is its influence through its generality and superior responsibility. In short, this philosophy will show that industrial relations, instead of being left to a dangerous empiricism and an oppressive antagonism, must be systemized according to moral laws. The duty to the lower classes will not consist in alms-giving, which can never be more than a secondary resource, nor made reconcilable with any high social destination, in the present advanced state of human condition and dignity. The obligation will be to procure for all, suitable education and employment,—the only conditions that the lower classes can justly demand. Without entering on the perplexed subject of wages, it is enough to say that their settlement will be largely influenced by the same agency. We need not inquire whether any political institutions will in course of time embody social securities of this kind: it is enough that the principle will remain eminently moral, in as far as it will be efficacious and harmonizing.

Reciprocal effects.

Such will be the effect on society of the philosophical preparation for the new system. It is very observable that the reciprocal action on philosophy will be no less beneficial. In such a combination, the people will give to the philosophers more than they will have received from them. The popular adhesion will be the safeguard of the spiritual power against aggression from the temporal, such as will be instigated by human passions under the positive system, as under every other, notwithstanding its milder practical activity, and the increased sway of reason over conduct. On the one hand, the rich men may show their pride of wealth on occasion of the material dependence of the speculative class; and these again may manifest the disdain which men of theory are wont to feel toward men of practice: and then will the people become the regulators of their conflicts, more even than in the Middle Ages, being indebted to the one power for education and moral influence, and to the other for employment and material assistance; and always holding the balance between them, as of old.

Preparatory stage.

If such be the prospect of the normal condition, it is easy to describe the preparatory stage which is near at hand. If popular participation is necessary to the new spiritual authority in its established condition, much more must it be so as a help to attain that condition. The wise permanent advocacy of popular interests is the only means by which the people can be taught the importance of the philosophical action which statesmen scoff at: and, when the spiritual power has become strong enough, its intervention in the collisions which must happen frequently in the absence of industrial system, will make its value more felt, and its function better understood, perpetually, by all classes. The classes which now recognise the supremacy of wealth alone will then be led by decisive, and sometimes very painful experience to implore the protection of the spiritual authority which they now regard as purely chimerical. The same causes which will make it the arbiter in collisions will make it the moderator in the social controversies in which already the need of such an influence is sorely felt: and on such services will rest its power, because they will command free assent and allegiance. There is nothing to be hoped from the political controversies which agitate the upper classes. Their disputes about the substitution of persons, ministerial or royal, have little interest for the bulk of society, and have no organizing tendency. The popular point of view is the only one which naturally offers a survey sufficiently large and clear to connect the present with the whole of the past, and to give an organic direction to the general mind. No agitation about political rights will meet the popular need, which can be satisfied with nothing more restricted than security of Education and Employment; and these can be obtained by no means short of social reorganization. This is the strong bond between popular needs and philosophical tendencies; and by means of it, the true social point of view will prevail in proportion to the share borne by the claims of the lowest classes in the great political problem. When the positive philosophy shall have penetrated that class, it will doubtless find a readier and happier reception than in any other; and the reaction that will ensue upon the higher classes will be no less fortunate, as enlightening them, in the only possible way, in regard to the whole social situation. In the midst of the painful conflicts which must recur till the conditions of order and of progress are fulfilled, the true philosophers who will have foreseen them will be prepared to exhibit the great social lessons they afford, and will convince the hostile parties that political measures are altogether inadequate to the cure of social evils. These few remarks may direct the reader's attention to the connection between the systematic development of the positive philosophy and the social establishment of the popular cause,—exhibiting the alliance that is needed between a great idea and a great force; and I could not close my general estimate of the spiritual reorganization with a more emphatic statement.

Promotion of Order and Progress.

To the reader's mind it may be safely left, to compare the conditions of order and of progress in the existing state of things, and in that which is to come. The new philosophy takes up the disorder at its source, and reorganizes opinions, which are next to pass into morals and manners, and lastly, into institutions. It adopts positive methods as well as doctrines, transforms the position of existing questions, the way of treating them, and their preparatory conditions: thus affording a triple logical security for social order. Subordinating the spirit of detail to that of generality, and therefore the notion of right to that of duty, it demonstrates the moral nature of the chief social difficulties. It substitutes the relative for the absolute spirit, and thus regards the whole past as a gradual evolution of the human mind and destiny, preparatory to present and future action. Lastly, it educes the science of Sociology, and assigns its position in the scale of human knowledge, under indisputable conditions, which exclude the incompetent from interference, and devolve these lofty contemplations upon the rare order of minds that are competent to them. Such is the promise with regard to Order. As to Progress,—the revolutionary party, which alone is progressive, is by no means obliged to desert the great rules which have advanced it thus far; but only to strip them of their absolute metaphysical character, and to accept and use them as relative: and in fact, when the ancient system is fairly discarded, and the new order is steadily growing up, the dogmas of the progressive party will acquire new strength, and admit of a bolder application than ever. Whatever demolition remains to be effected will be done with the avowal that it is a transitional act, necessary to open the path of progress. We have seen that the critical spirit, while duly subordinated to the organic, is rather favorable than hostile to its social efficacy; and in its renovated and clearly-defined state it must become a genuine aid to progress, by exposing the impotence of metaphysicians and legists as a governing power, and by making war with the intellectual and moral vices which impede the growth of the new social elements. Thus will the positive philosophy fulfil the conditions laid down at the beginning of this book. Without effort, and without inconsistency, it will show itself to be more organic than the retrograde school, and more progressive than the revolutionary, so that it may be described indifferently by either attribute. Tending to unite or to dissolve all parties by the satisfaction of all their reasonable desires, the positive school may hope to gather disciples from every class. Among the clergy, there may be some who can appreciate the restoration of spiritual authority, amidst the change of conceptions on which it must be grounded. Among the military class, there must be some who can rightly understand their existing function of preserving material order till it is systematically provided for. The scientific and æsthetic classes must hail a philosophy which will elevate them to the highest social rank and rule. The industrial leaders would appreciate, if their education did but admit of it, the protection to be afforded them against popular collisions, and the award of temporal supremacy. And I have shown why the positive school is likely to have the emphatic support of the lowest class of all. Among the equivocal and anomalous orders which can be included in none of these, there must be individuals who would gladly enter the positive school;—metaphysicians who see the virtue of generality in contrast to excessive speciality; and literary men, and even lawyers, who might find stimulus and scope for the exercise of their particular talents of exposition and discussion. I have never concealed my conviction that no collective adhesion can be looked for during the stage when men's prejudices and passions will be hurt more sensibly than their best desires will be gratified. The empiricism and egotism that belong to our anarchical condition are but too congenial to the youth of society: and every class resists the proposal of a new classification: and thus all accessions will be, for some time, of individuals. But from all quarters due support will arise. If, in the last century, the negative philosophy, with all its anarchical tendencies, found support even from kings, because it corresponded with the needs of the time, we may surely hope for an equivalent reception for the positive philosophy in the nineteenth century, when from it alone we may hope for what we need,—the re-establishment of a normal condition in the most advanced state of society, and the extinction of the collisions which are occasioned by intellectual and moral anarchy, and which are spreading with its propagation.

National participation.

I have adhered throughout my survey and speculation to my original limitation,—speaking solely of Western Europe, and taking no notice whatever of the rest of the human race. Such must be the course of the positive philosophers, who must leave the Asiatic tribes, and even those of Eastern Europe, to work out for themselves their preparatory conditions, and enter into the most advanced, as the circumstances of a future age shall determine. It is not our business to decide by anticipation what that preparatory course must be, nor when it shall terminate; nor to suppose that each race or nation must imitate in all particulars the mode of progression of those which have gone before. Except for the maintenance of general peace, or the natural extension of industrial relations, Western Europe must avoid any large political intervention in the East; and there is as much to be done at home as can occupy all the faculties of the most advanced portion of the human race.

Though the five nations of Western Europe are essentially homogeneous, there are differences among them all which affect the reception and establishment of the positive philosophy and organization. The survey that we have made of the negative and positive progression affords us materials for a judgment as to the aptitude of each, all local prejudice being, as far as possible, discarded.

France.

France is pointed out by all evidence as the chief seat of social reorganization, from the decomposition of the old system being earlier and more complete there than elsewhere, and the various kinds of scientific and æsthetic evolution being, if not more advanced, of greater social influence than in other countries. Industry, if not specially developed to the greatest extent, has carried up the temporal power to an unparalleled political position; and there is a national unity in France which is remarkable for its completeness and permanence. The disposition of men of science, philosophy, and art, all over Europe, to regard Paris as a common country, is as significant as the subordination of all France to Paris, in showing that the foremost place, which has been so hardly acquired, is likely to be maintained.

Italy.

I am disposed to think that Italy comes next, in spite of her want of nationality. The military spirit is more nearly extinct there than anywhere else; the theological emancipation is complete, as regards cultivated minds; and there may we find the strongest traditional sense of the division between the spiritual and the temporal powers. The scientific and industrial evolutions are almost as much advanced as in France, but with less social effect, from the extinction of the theological and aristocratic spirit being less popular. Both are nearer however to their final ascendency than in any other nation. The æsthetic evolution is, as I need hardly say, so nearly complete and universal, as to have sustained speculative life in even the lower order of minds. The want of nationality must keep back Italy from such a political leadership as is reserved for France; but the propagation of the original movement is not hindered by this. On the contrary, the spiritual reorganization may be thereby stimulated, as a result both of the special presence of Catholicism and of the greater eagerness for a European unity, from the impossibility of establishing an Italian one; that European unity being obtainable only through intellectual and moral regeneration.

Germany.

Next comes the German nation, because the military or feudal, and even the religious spirit, while less thoroughly exhausted than in Italy, is not so dangerously incorporated with the movement of modern society as in England. Nor is the political influence of Protestantism so inwrought and universal; nor has the temporal concentration of power assumed the aristocratic form, but the far more favorable one of monarchy. The great danger is from the metaphysical spirit, which is doubtless more prevalent there than anywhere else; but it is certainly rapidly on the decline. Apart from that, the positive evolution is, in nearly all its departments, more advanced than in England, and especially in regard to the social influence which belongs to it. Though the philosophy may be mistaken, the philosophical spirit of the Germans disposes them to general meditation, which compensates largely for the dispersive tendencies of our scientific specialties. The industrial evolution, while less developed than in England, is nearer to its ultimate destination, because its expansion has been more independent of aristocratic rule. The want of nationality, occasioned mainly by Protestantism, may be of a different character from the Italian; but it acts in the same way as a stimulus to the positive regeneration which is to be the common inheritance of Western Europe.

England.

The English nation seems to be, for reasons already exhibited, less prepared for such an issue than any other branch of the great family, except Spain, where retarding influences of a special kind have been at work. We have seen how the feudal spirit, and the theological also, have preserved a dangerous political consistence, by means of the modification which they have gradually undergone,—a consistence which is compatible with partial evolutions of considerable duration, but is a serious obstacle to final reorganization. The retrograde, or at least the stationary system had been organized there with unusual strength, in both its spiritual and its temporal province. The English constitution is as hostile as Jesuitism itself to human emancipation; and the material compensation which has been offered as a bond of incorporation with the modern movement has become, amidst a great excitement of industrial activity, a serious political hinderance in many ways,—among others, by protracting the sway of an aristocracy which stands, in virtue of a military principle, at the head of a practical movement; by vitiating the mental habits of the people at large, through an exorbitant prevalence of concrete and utilitarian views; and again, by encouraging, to the injury of the national morals and manners, a pride and cupidity which tend to separate the English people from the rest of the European family. This disposition has impaired, as we have seen, the development of science, and also of art, with the exception of Poetry, great as are the individual examples of achievement in both: and the social influence of both is more immature than in France, Italy, or Germany. All this is no hinderance to the new philosophy finding more effectual help from individuals in England than anywhere else, except in France, prepared as such minds are by the social state in which they live. They are saved from the chimerical hope, so fatal on the continent, of redemption by means of a universal imitation of the British constitution, whose transitory and inadequate character must be better understood at home than on the continent. Again, if the practical spirit be exorbitant, it brings one advantage with it,—that, while it does not check general meditation in minds to which such contemplations are congenial, it gives them a character of clearness and reality, which is not to be found elsewhere. Finally, in consequence of the inferior social importance of scientific bodies, individual *savans* have more originality than on the continent, and can better withstand the dispersive tendencies that belong to the *régime* of speciality, the philosophical conversion of which will probably encounter fewer obstacles in England than in France. There is no occasion to justify at any length my assigning the last place to Spain. Though the retrograde system is in reality less substantial than in England, it is more repressive, from being badly administered. The extreme enforcement of Catholicism has been less favorable than in Italy to mental emancipation, and to the maintenance of the political habits of the Middle Ages in regard to the separation of the two powers. In the last respect the Catholic spirit was much impaired through a too close incorporation with the system of government; so as rather to excite vicious theocratic tendencies than to promote a rational co-ordination between the moral and the political power. These considerations however do not impair the claims of Spain to admission into the great European commonwealth, where former connection is an all-sufficient reason for present inclusion, notwithstanding some incidental embarrassment, philosophical or political, that may thence arise. The resistance of the Spanish people to the oppressive invasion of Bonaparte testifies to a moral energy and political tena-

Spain.

city which, in that country particularly, reside in the mass of the people, and guaranty their fitness for the final system when their special liabilities to retardation shall have been outgrown.

Co-operation of thinkers.

We see that the preparation for the positive system is unequal among these five nations: and it follows that in the working out of the scheme their respective advantages should be laid hold of, and converted into means of fulfilment. This must be done by the co-operation of the best minds in each nation, who should systemize the intellectual and moral offices which are declined more and more by the European governments, and delivered over to independent thinkers. Such thinkers may form a positive Council, under one form or another, and act either by reviewing and renovating all human conceptions; or by instituting seats of education for the advancement of positive knowledge, and the training of fit coadjutors; or by regulating the application of the system through unremitting instruction of all kinds, and even by philosophical intervention in the political conflicts which must arise till the old social action is exhausted.

Results of the Sociological theory.

By the review of the former social states of mankind, and the sketch of the future organization of society which I have now completed, I trust I have fully redeemed my promises, as offered both at the beginning of this work, and at the outset of the sociological portion. At a time when moral and political convictions are fluctuating for want of a sufficient intellectual basis, I have laid the logical foundation of firm convictions, able to withstand discordant passions, public and private. At a time when practical considerations are excessively preponderant, I have restored the dignity of philosophy, and established the social reality of sound theoretical speculations by instituting a systematic subordination of the one to the other, such as is essential to social stability and greatness. At a time when human reason is liable to be frittered away under an empirical system of dispersive speciality, I have announced, and even introduced the reign of the spirit of generality, under which alone a universal sentiment of duty can prevail.

These three objects have been attained by the institution of a new science, the last and most important of all, which is as positive and logical as any of the other sciences I have treated of, and without which the system of true philosophy can have neither unity nor substance. The future progress of Sociology can never offer so many difficulties as this original formation of it; for it furnishes both the method by which the details of the past may serve as indications of the future, and the general conclusions which afford universal guidance in special researches. This scientific foundation completes the elementary system of natural philosophy prepared by Aristotle, announced by the scholastics of the Middle Ages, and directly proposed, in regard to its general spirit, by Bacon and Descartes. All that remains for me to do is to co-ordinate the elements which I have passed under review, in the form of six fundamental sciences, under the heads of Method, Doctrine, and the general unity of the positive philosophy.

CHAPTER XIII.

FINAL ESTIMATE OF THE POSITIVE METHOD.

Now that we have completed our review of the six great sciences, it is evident that the hierarchical succession from Mathematics to Sociology is the means by which our understanding is gradually borne up to the definitive point of view of the positive philosophy, the true general spirit of which could not otherwise be disclosed. We have traced an individual evolution corresponding to the aggregate one, that we may, in a general way, consider to have set out from the conjoint philosophical and scientific action of Bacon and Descartes, in alliance with Kepler and Galileo. The entire survey was necessary to the estimate, methodical and doctrinal, of each principal phase of rational positivism: and the homogeneousness of the partial disclosures has prepared us for their convergence toward an identical final philosophy,—never till now ascertained. All that remains for me to do is to exhibit the co-ordination of the different conceptions, logical and scientific, under a genuine principle of unity; by which we may discern what will be the intellectual and social action of the system which will henceforth guide the conduct of human life. That such a philosophical unity is the first condition of social reorganization the preceding chapter has shown us; and those who do not feel the social want are becoming more and more aware of the speculative necessity. The ancient system being worn out and discarded, and new materials and instrumentalities being obtained, the time has fully arrived for consolidating the great speculative evolution of the last two centuries, under penalty of sinking into the mental degradation which disgraced the old Greek and Mediæval populations on the expiration of an old *régime*, and before the institution of a new.

Principle of Unity.

The necessary co-ordination is an easy task, because positivity has been presented to us in a series of states, more and more complete, each of which includes all that went before; so that the last, —the most complex that human reason can ever be employed upon, —is the universal bond of connection among all positive speculations whatever. Laborious as has been our examination of the whole series, our conclusions may, by such preparation, be drawn briefly, and without any difficulty.

Which element shall prevail.

The chief question is as to which of the speculative elements must finally prevail over the rest,—philosophical unity requiring the preponderance of one, for the practical development of the positive principle. The constitution of the scientific hierarchy shows that the intellectual pre-eminence must belong either to the first or the last degree of the scale; either to mathematics or sociology; for they alone can evidently be universal,—the one from its origin, and the other from its destination. Mathematical science (in which we may here include astronomy, as the embodiment of mathematics) claims a logical supremacy, in virtue of the indisputable extension of geometrical and mechanical laws to all possible orders of phenomena. In the other view, Sociological philosophy (in which we may include biology, as its basis) may establish its claim, now that the condition of genuine positivity is fulfilled, since all speculations of every kind may be regarded as necessary results of the speculative evolution of the human race. It will be undisputed that the two intermediate sciences, physics and chemistry, have no pretension, on account of either origin or destination to be more than powerful auxiliaries of the rival impulsions. The question lies between mathematics and sociology.

First general Conclusion.

According to my theory, Mathematics necessarily prevailed during the long training of the human mind to positivism; and Sociology alone can guide genuine speculation when its basis is once fully ascertained. This distinction, which is the first and greatest of our general conclusions, involves at once the explanation and the solution of the lamentable antagonism which has been growing up for three centuries between the scientific genius and the philosophical,—the one having claimed a positivity, and the other a generality, which are now for the first time reconciled. Before the progression of the human race was referred to natural laws, men neglected the consideration of generality for that of positivity, because the generality remained connected with a worn-out system which had to be discarded before progress could be made: but now that the positive character is extended to all orders of speculation, sociological conceptions may resume the supremacy which belongs to their nature, and of which they were only provisionally deprived during the last mediæval period, by the temporary exigencies occasioned by the positive evolution.

We have seen, throughout this Work, that Mathematical science is the source of positivity: but we have also seen that mathematical conceptions are by their nature incapable of forming a genuine, complete, and universal philosophy. Yet all the attempts for three centuries past to constitute a philosophy that should replace that which was worn out have proceeded on the mathematical principle. The only one of all these premature attempts which deserves eternal remembrance on account of its services is the Cartesian philosophy, which furnished the type of those that followed, while very superior to them all. This great scheme, which laid down geometry and mechanics as the basis of universal science, happily fostered for a century, in spite of its enormous inconveniences, the rise of positivity in all the chief departments of inorganic philosophy:

but it not only failed to include moral and social researches, and was therefore imperfect, but it introduced disturbance into the simplest biological speculations, which has not even yet entirely subsided. However vast might be the progress of mathematical theories, they could never get over this imperfection, which became the more manifest, the stronger were the efforts to apply them; and by degrees their application was left to inferior workers, through a confused, but increasing sense in superior minds of their inaptitude. The attempts to find a starting-point in the physico-chemical sciences, unjustifiable as they were, afford evidence of the need that was felt of a universal connection, and explain why even philosophers, properly so called, have deserted the moral and social point of view for what they took to be a surer basis. The fruitlessness of the notion is no evidence that it was given up by scientific men, who have still hoped, with every accession of discovery, to find their mathematical principle universally applicable at last; and the practical effect of their persuasion was simply to prejudice them against any other systematic conception, and even against any portion of natural philosophy which was too complex to be brought under mathematical management. This is, even now, the great obstacle in the way of philosophical advancement; and in order to see how alone positive speculations may be brought into universal connection, the best way evidently is to compare the opposite courses of proceeding,—the mathematical and the sociological.

The Mathematical element.

The claims of the mathematical spirit relate chiefly to Method; yet, as scientific logic there first arose, it could develop all its characteristics only by being extended to more and more complex subjects, till, through greater and greater modification, it finally entered into the most difficult speculations of all, and those which required a combination of all anterior means of investigation, as well as those which were proper to themselves. If, then, scientific men should stand forward to represent the positive attainments made in their respective sciences, the sociologists would be the only ones who could be regarded as having a complete knowledge of the positive method, while the geometers would have a more imperfect conception of it than any others, precisely because they know it only in its rudimentary state, while the sociologists alone would have carried it out completely. I have shown how the relative point of view, in opposition to the absolute spirit of the old philosophy is the distinctive mark of the positive philosophy;—now, this relative spirit is scarcely perceptible at all in mathematical conceptions,—the extreme facility of mathematical deduction, often little other than technical mechanism, tending to deceive us as to the real scope of our knowledge. There is no lack of examples among geometers of inquisition into subjects wholly inaccessible to human reason; nor of obstinacy in substituting argument for observation. Sound biological speculation, on the contrary, perceives philosophy to rest on an historical basis; and this fulfilment of the first condition of positivism suffices to give sociology the supremacy. Again, the sense of the invariableness of natural laws can not be much developed in mathematical researches, though it originated there; because the extreme simplicity of geometrical and mechanical phenomena hardly admits of a full and practical generalization of this great philosophical idea, notwithstanding the valuable confirmation arising from its extension to celestial phenomena. Hence it is, that mathematicians drop the supposition of natural laws as soon as they encounter phenomena of any considerable degree of complexity, and especially when human action is in any way concerned; as we see by their pretended calculation of chances, through a special application of mathematical analysis,—an extravagance which is wholly incompatible with true positivity, but from which the vulgar of our algebraists still expect, after a century of wasted labor, the perfecting of some of the most difficult of human studies. In the other sciences we find still increasing manifestations of the invariableness of natural laws; but in sociology alone we find the full illustration of it, because there it is extended to the most complex of all events, which were excluded even by the Cartesian philosophy. Whichever way we look at the positive method, we shall perceive the eminent logical superiority of the sociological over the mathematical point of view. All the logical resources that the human mind can employ are exemplified in mathematical practice; but, through the extreme simplicity of the subjects to which they are applied, the most important of the means can not be defined; and their scope can be duly estimated only when their chief destination is found, amidst the difficulties of an increasing complexity of phenomena, in the series of departments of natural philosophy. A reaction ensues, which can not but be highly favorable to mathematical science, while it exposes the precise value of its claims. The comparative method proper to biology, and the historical method proper to sociology, are the two greatest of logical creations, achieved in the face of extreme scientific difficulties: but the disgraceful ignorance of almost all geometers of these two transcendent methods of logical investigation shows that it was not mathematics that furnished the conception, though some examples of them may be found in mathematical science, fruitless and unintelligible to all who have not derived them from their original source. So much for the logical estimate.

As for the scientific,—the superiority of the sociological spirit is no less evident, in regard to the universality required. Though the geometrical and mechanical point of view is universal, in as far as that the laws of extension and motion operate, in an elementary way, upon all phenomena whatever, yet, however valuable may be the special indications thence arising, they can never, even in the simplest cases, obviate the necessity of a direct study of the subject; and that direct study must always be the preponderant one. The mathematical conditions moreover become vague and imperfect in proportion to the complexity of the case, though they can never be absent, and must always be taken into the account, as I have shown by my estimate of astronomical conditions in sociology. In fact, though not in principle, mathematical science has restricted its claims to the field of inorganic philosophy, scarcely even contemplating the admission of chemistry in some remote future; a pretension very unlike that of the universality which was once proposed. Hence the necessity of other guidance in moral and social pursuit; and hence the confusion and barren social agitation of modern times. If restricted to the inorganic domain, the supremacy of mathematics becomes much less injurious: but even there it can last only till the physicists have learned to take the use and application of this powerful logical instrument into their own hands. As the most general laws of inert nature must remain for ever unknown to us, from our inevitable ignorance of cosmical facts, properly so called, the mathematical spirit can frequently handle physical questions only by such hypotheses about the mode of production of phenomena as I have before exposed. When the repugnance of physicists to admit geometers to solve physical problems shall have taken due effect, the supposed mathematical philosophy, which appeared, two centuries ago, to have taken possession of the whole field of human speculation, will be reduced to one province outside its own,—that of astronomy, which appears to belong properly to it, in virtue of the geometrical and mechanical nature of its corresponding problems. Even there, if we go to the extremity of the case, the mathematical interference in astronomy has a precarious and forced character, which will prove to be merely transitory. It is certain that astronomical, like physical, discovery has been much impeded by the intrusion of the geometers, who do not perceive, in the one case, any more than in the other, that the pursuit of any science is the work of students who understand the special destination of the instrument, logical or material, as well as its structure. The mathematicians would reduce the whole band of physical astronomers to the rank of mere settlers of certain coefficients, to the serious injury of astronomical discovery. In astronomy itself, then, it appears that the sway of the mathematical spirit is likely, not to increase, but rapidly to decline, till it shall be at length restricted to its own province of abstract and concrete mathematics. It is only owing to the temporary needs of the human mind, during the preparation for discarding the old philosophy, that any other expectation was ever justifiable.

From these considerations I have been able to show, at least in the way of exclusion, that, on both logical and scientific grounds, the sociological spirit must be recognised as supreme, even without any elaborate contrast, of its high aptitudes for universal direction with the impotence proper to the mathematical spirit. As the science is newly created, and now first proposed, this is not the place to exhibit at length its certain reactionary effects on the other sciences; nor would the few special examples which might already be cited meet with due appreciation till our mental habits are somewhat improved: so that it is chiefly *à priori*, under sound philosophical regulation, that the rational supremacy of the sociological spirit over every other kind, or rather degree, of the scientific spirit may be established: but the immediate grounds of this procedure are so unquestionable that they can not but be assented to by all duly-prepared minds.

The Sociological element.

The only really universal point of view is the human, or, speaking more exactly, the social. This is the only one which recurs and is perpetually renewed, in every department of thought; in regard to the external world as well as to Man. Thus, if we want to conceive of the rights of the sociological spirit to supremacy, we have only to regard all our conceptions, as I have explained before, as so many necessary results of a series of determinate phases, proper to our mental evolution, personal and collective, taking place according to invariable laws, statical and dynamical, which rational observation is competent to disclose. Since philosophers have begun to meditate deeply on the intellectual phenomena, they have always been more or less convinced, in spite of all prepossession, of the inevitable reality of these fundamental laws; for their existence is always supposed in every study, in which any conclusion whatever would be impossible if the formation and variation of our opinions were not subject to a regular order, independent of our will, and the pathological change of which is known to be in no way arbitrary. But, besides the extreme difficulty of the subject, and its vicious management hitherto, human reason being capable of growth only in social circumstances, it is clear that no decisive discovery could be made in this way till society should have attained a generality of view which was not possible till our day. Imperfect as sociological study may yet be, it furnishes us with a principle which justifies and guides its intervention, scientific and logical, in all the essential parts of the speculative system, which can thus alone be brought into unity. It appears to me that the mere existence of this book is a sufficient testimony to the reality and fertility of the new general philosophy; for it presents the spectacle of the whole range of sciences subjected to one point of view, without interference with the independence of any, and with a confirmation instead of a weakening of their respective characters, by the power of a single thought—by the application of a single general law. Brief as my expositions have necessarily been, thoughtful readers can not but be aware of the new light, generated by the creation of Sociology, cast upon all the foregoing sciences. Considering the inorganic sciences alone, in which such philosophical intervention is most questioned, we shall find the following results:—

1. In Chemistry, the conception of facultative dualism, by which difficulties in high chemical speculation may be dealt with which had hitherto appeared insurmountable:

2. In Physics the foundation of a sound theory of scientific hypotheses, for want of which the positivity of the leading conceptions was seriously impaired:

3. In Astronomy, the just estimate of sidereal astronomy,* and the reduction of our researches to our own system:

4. In Mathematics, the rectification of the basis of Rational Mechanics, of the whole system of geometrical conceptions, and of the first procedures of analysis, ordinary and transcendental.

All these improvements, tending alike to consolidation and advancement, are due, more or less directly, to the supremacy of the historical view proper to sociology; the only view which permits our first and constant attention to be given to the statical and dynamical working out of questions relating to the respective constitution of the various parts of natural philosophy.

We may thus fairly decide that the philosophical principle of unity is afforded by Sociology, and not by Mathematics. As the varying constitution of the speculative class necessarily represents the corresponding situation of the human mind in general, the nascent positivism of the last three centuries has given to the mathematicians more and more of that authority which, till the end of the mediæval period, had belonged to moral and social researches. This provisional anomaly will now come to an end; for, when sociological theory has once reached the positive state, there is nothing except the opposition of the ignorant and the interested, to prevent the human view from resuming its natural place at the head of all human speculation. I have said that this conclusion was not only the first but the greatest: and in fact, the question of supremacy is the only one important to decide, at the point that we have now reached. The only possible alternative is now decided, by considerations drawn from abstract science alone, according to the original conditions of this Work;—that abstract science which, after Bacon, I have called the First Philosophy, because it is the basis of all speculation whatever; but the same decision may be reached by considerations of concrete science, and even by æsthetic contemplation: for the sociological organization of positive philosophy favors their expansion; whereas the mathematical mode, if fully carried out, would be fatal to it.

In regard to the first order of evidence,—if abstract science must be the main subject of speculative study, it must serve as the basis of concrete science, which can acquire rationality only by the ascertainment and due description of the philosophical elements concerned; and the mathematical spirit, urged too far, and countenancing the use of analysis alone, is incompatible with reality and concentration necessary to the study of the existence of actual beings. The sociological spirit, on the contrary, while duly preserving its abstract character, is highly favorable, by both complexity of subject and generality of view, to the mental dispositions requisite for the rational cultivation of natural history, which indeed is, from its human and synthetic character, much more congenial with sociology than with any other fundamental science,—not excepting even biology. The general interests of concrete study require therefore that the direction of abstract philosophy should reside in the science in which the inconveniences of abstractness are reduced to the utmost, in virtue of the most complete reality of the habitual point of view. The same considerations apply to the æsthetic case. The sociological mode must be fittest to regulate the subordination of the sense of the beautiful to the knowledge of the true: and the scientific spirit most disposed to unity must be most suitable to the synthetic character of æsthetic contemplation, which always, perceptible or not, relates to the emotions of the human being. If the positive philosophy has been often reproached with its anti-æsthetic character, it is owing to the sway of the mathematical spirit for three centuries,—the dispersive and mechanical tendency of which affords fair ground for the reproach. By its contrasting character of true and fertile unity, the sociological philosophy will prove itself more favorable to Art than the theological, even in the polytheistic period. The positive spirit, in its sociological form, undertakes to disclose the general laws of the human evolution, of which the æsthetic evolution is one of the chief elements; and the requisite historical process is eminently adapted to exhibit the relation which must ever subordinate the sentiment of ideal perfection to the idea of real existence: and by discarding henceforth all superhuman intervention, sociological philosophy will establish an irreversible agreement between the æsthetic and scientific points of view.

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* Compare p. 168, note.

There may be somewhat more doubt in regard to the remaining case,—that of Industry; because, depending as it does on the knowledge of the inorganic world, geometrical and mechanical first, and then physical and chemical,—it may appear to be in danger of abandonment if the mathematical spirit loses its rank in scientific speculation. I might allege in the first place, that there would be no great harm in retarding the progress of a kind of activity which, from its facility, and its adaptation to the commonest inclinations, threatens to absorb all others that are more noble. There can never be any serious apprehension that the growth of ideas and feelings suitable to a renovated social condition will proceed so fast and so far as to occasion any dangerous industrial negligence: and if such a thing could happen, the new philosophy, occupying the true point of view, would sufficiently rectify the fault. The mathematicians may be incapable of estimating social researches, but sociologists are free from their blindness, and can never possibly underrate mathematical labors. Again, we stand in much greater need, for industrial advancement, of a better use of means already acquired than of the unregulated accumulation of new ones; so that the restraint of synthetic tendencies is precisely the safeguard that we want against the desultory enterprises of wild analytical impulses: and thus again is the sociological *régime* more favorable than the mathematical to material improvement. Once more, when the action of man upon nature is duly systemized under the new body of doctrine, it must be done under the guidance of sociological philosophy, which alone is able to combine all the scientific aspects requisite for the great work,—the conditions and difficulties of which are yet scarcely suspected by our engineers, as I hinted on a former page. Near the beginning of the volume I pointed out the true principle which must regulate the agreement between contemplation and action: and this reference must suffice, under my inability to go further into the subject here. Thus it appears that the supremacy of sociological philosophy over the mathematical is confirmed by all concrete, æsthetic, and technical considerations. The toilsome and protracted preparation by which this position must be attained is shown by the whole economy of this Work; and especially by the expositions of this book. The vigor and patience requisite for the scientific and logical preparation, and for the ability to connect special progress with the general movement, form a striking contrast with the ease with which mathematicians qualify themselves for the authority which they claim. A few years spent in pursuing one kind of studies, so simple as to be accessible to average ability are the mathematical qualification; but the result has been, in the most triumphant days of mathematical ambition, a supremacy more apparent than real, and wholly destitute, amidst all its pretensions to scientific universality, of the practical reality which belongs to sociological ascendency.

Solves antagonisms.

This unity, thus established and regarded both historically and dogmatically, puts an end to the long and fatal antagonism between the conceptions which relate to Man, and those which concern the external world. Hitherto they have been concluded to be irreconcilable; but my philosophical solution combines them entirely and for ever. I need not repeat the history of this antagonism, from the first antipathy between the theological and positive spirit, owing to their assumption of the opposite points of view, through the Cartesian compromise, and the struggles of the mathematical philosophy with expiring theology and metaphysics, up to the present hour, when the solution is offered by the extension of the positive spirit to moral and social speculation, affording all the positivity of the one and all the generality of the other. With this antagonism disappears that other fatal one, closely implicated with it, by which intellectual progress appeared to be contradictory to moral progress. The state of things under which mental requirements gradually prevailed over moral needs, dates from the beginning of the modern transition,—and it was its most deplorable condition. The more deplorable that condition, the more regard is due to the philosophy which alone can resolve the antagonism. We have seen how this philosophy takes up the best work of Catholicism, where Catholicism let it drop, through its connection with a worn-out system. The natural preponderance of Morals which I have shown to be ascribable to the positive system, is quite as indispensable to the efficacy of the intellectual, as of the social evolution; for indifference to moral conditions, so far from corresponding with the exigencies of intellectual conditions, is a growing impediment to their fulfilment, inasmuch as it impairs the sincerity and dignity of speculative efforts, already too subservient to personal ambition, so as to destroy, in course of time, the very germ of genuine scientific progress. To make this connection perfectly clear, it is necessary to strip away the last metaphysical illusions, and show what is the true human point of view, —that it is not individual but social; for under either the statical or the dynamical aspect, Man is a mere abstraction, and there is nothing real but Humanity, regarded intellectually or, yet more, morally. It is only through its holding this view, that the theological philosophy has retained any of its influence to this day; and the fate of the metaphysical philosophy is decided by its inability to treat of Man otherwise than individually. The same vice marked the positive system, while it was directed by the mathematical spirit alone; and this compelled philosophers, as Cabanis and Gall, for instance, to fix on biology as the centre of scientific unity. This was so far a good as that it brought the modern centre of organization much nearer to its real seat; but it would not answer further than for a necessary transition; and it protracted the old intellectual system by impeding the development of sound social speculation, which it looked upon as merely a natural corollary of biological studies. Whether the science of the individual is instituted metaphysically or positively, it must be utterly ineffectual for the construction of any general philosophy, because it is excluded from the only universal point of view. The evolution of the individual mind can disclose no essential law: and it can afford neither indications nor verifications of any value unless brought under the methods of observation taught by the evolution of the human mind in general. Thus, the biological phase is only the last introductory stage, as each of the preceding sciences had been before, to the development of the positive spirit, by which its own scientific and logical constitution must be consolidated. The preparation being fully accomplished, and the positive spirit having reached the last degree of generality, we may judge of its claims by comparing it with the programme drawn so powerfully by Descartes and Bacon, whose chief philosophical aspirations are thus found to be united in their fulfilment, however incompatible they once appeared. Descartes denied himself all social research, as we have seen, to devote himself to inorganic speculation, from which he knew that the universal method must take its rise; while, on the contrary, Bacon applied himself to the renovation of social theories, to which he referred the advancement of natural science. The tendency of Hobbes was the same; and he was the type of the school. The two procedures, complementary to each other, accorded, the one to intellectual demands and the other to political needs, a too exclusive preponderance which must reduce both to merely provisional rank, —useful as both were in their place. Descartes directed the agency of the positive spirit in inorganic science: and Hobbes brought to light the germs of true social science, besides assisting to overthrow the ancient system, which must be cleared away to make room for the new. The one method prepared the general position of the final question, and the other opened logical access to its solution. This work results from the combination of the two evolutions, determined under the influences of the great social crisis, by the extension of the positive spirit to subjects verging on social research. Thus, the new operation consists in completing the double initiatory procedure of Descartes and Bacon, by fulfilling the two conditions, indispensable, though long seeming irreconcilable, adapted by the two chief schools which prepared the way for the positive philosophy.

Spirit of the Method.

Such is the relation of this solution to the present and the past. As to the future,—I need not point out the unreasonableness of any fears that the supremacy of the sociological philosophy can injure any of the anterior sciences. That supremacy would be compromised by the neglect of any one of them, even if such neglect were possible. It may and will be the case that irrational and undisciplined labors will meet with less favor and less impunity than hitherto; and also that the highest scientific capacity, and the most earnest public attention, will be directed to sociological researches, as the best ability and interest always are at the command of the needs of their time. But there is nothing to lament in either of these results. As to the effect on private education, there is no greater cause of anxiety. The sociological theory requires that the education of the individual should be a reproduction, rapid but accurate, of that of the race. In his brief career, he must pass through the three stages which an aggregate of nations has wrought out with infinite comparative slowness; and if any material part of the experience is evaded, his training will be abortive. For the individual then, as for the race, mathematical speculation will be the cradle of rational positivity; and the claims of geometers are certain, therefore, of just consideration,—and the more, as the order and urgency of the needs of the human mind become better understood. But it will not be forgotten that a cradle is not a throne; and that the first demand of positivity, in its humblest degree, is to have free way, and to pursue it up to the point of universality, which is the only limit of genuine education.

These are the considerations which prove the fitness of the positive philosophy to reconcile the antagonistic methods of connecting our various speculations,—the one taking Man and the other the external world for its starting-point. Here we find the solution of the great logical conflict which, from the time of Aristotle and Plato, has attended the entire evolution, intellectual and social, of the human race; and which, once indispensable to the double preparatory movement, has since been the chief obstacle to the fulfilment of its destination.

Having thus ascertained the spirit of the positive method, I have to indicate briefly its nature and destination, and then, its institution and development, in its complete and indivisable state; that its attributes, hitherto spontaneous, may be duly systemized, from the sociological point of view.

Nature of the Method.

The Positive philosophy is distinguished from the ancient, as we have seen throughout, by nothing so much as its rejection of all inquiring into causes, first and final; and its confining research to the invariable relations which constitute natural laws. Though this mature view is yet too recent to be fully incorporated with all our studies, it is applied to every class of elementary conceptions, and is firmly established in regard to the most simple and perfect,—showing that a similar prevalence in the more complex and incomplete is merely a question of time. The true idea of the nature of research being thus attained, the next step was to determine the respective offices of observation and reasoning, so as to avoid the danger of empiricism on the one hand, and mysticism on the other. We have accordingly sanctioned, in the one relation, the now popular maxim of Bacon, that observed facts are the only basis of sound speculation; so that we agree to what I wrote a quarter of a century ago,—that no proposition that is not finally reducible to the enunciation of a fact, particular or general, can offer any real and intelligible meaning. On the other hand, we have repudiated the practice of reducing science to an accumulation of desultory facts, asserting that science, as distinguished from learning, is essentially composed, not of facts, but of laws, so that no separate fact can be incorporated with science till it has been connected with some other, at least by the aid of some justifiable hypothesis. Besides that sound theoretical indications are necessary to control and guide observation, the positive spirit is for ever enlarging the logical province at the expense of the experimental, by substituting the prevision of phenomena more and more for the direct exploration of them; and scientific progress essentially consists in gradually diminishing the number of distinct and independent laws, while extending their mutual connection. I have explained before that our geometers have been led, by contemplating only the wonderful scope of the law of gravitation, and exaggerating even that, to expect and strive after an impracticable unity. Our intellectual weakness, and the scientific difficulties with which we have to cope, will always leave us in the midst of irreducible laws, even in regard to the interior of each science. The universality which is proper to the sociological point of view instructs us how to establish as wide a connection as our means admit, without repressing the spirit of each science under a factitious mathematical concentration. In this way, while sound generalization will be for ever reducing the number of really independent laws, it will not be forgotten that such progress can have no value whatever, except in its subordination to the reality of the conceptions which guide it.

Inquiry into laws.

Accordance with common sense.

The next important feature of the positive method is the accordance of its speculative conclusions with the development of popular good sense. The time is past for speculation, awaiting divine information, to look down upon the modest course of popular wisdom. As long as philosophers were searching into causes, while the multitude were observing indications, there was nothing in common between them: but now that philosophers are inquiring for laws, their loftiest speculations are in essential combination with the simplest popular notions, differing in degree of mental occupation, but not in kind. I have repeatedly declared in this work that the philosophical spirit is simply a methodical extension of popular good sense to all subjects accessible to human reason,—practical wisdom having been unquestionably the agency by which the old speculative methods have been converted into sound ones, by human contemplations having been recalled to their true objects, and subjected to due conditions. The positive method is, like the theological and metaphysical, no invention of any special mind, but the product of the general mind; and the positive philosopher takes the spontaneous wisdom of mankind for his radical type, and generalizes and systemizes it, by extending it to abstract speculations, which have thus obtained the advancement that they exhibit, both in their nature and treatment. It is only by the popular determination that the field of scientific research can be marked out, because that determination alone can be perfectly and certainly free from personal bias of every kind, and directed upon impressions common to all men; and it is in fact impossible to conceive of either the origin or the final unanimous propagation of positive speculations apart from the general impulse and interest in them. The commonest facts are, as I have often said, the most important, in all orders of knowledge; and we have seen that the best instrumentalities of rational positivity are the systemized logical procedures given out by common sense. We see how modern psychology, setting out from the opposite point,—from the dogmatic formation of the first principles of human knowledge, and proceeding to analyze complex phenomena by the method which we now reject in the case of the simplest,—has never yet, with all its toil and perplexity, risen to the level of popular knowledge derived from general experience. Public reason determines the aim as well as the origin of science;—directing it toward previsions which relate to general needs; as when, for instance, the founder of astronomy foresaw that, as a whole, it would afford a rational determination of the longitudes, though that result was not realized till Hipparchus had been dead two thousand years. The proper task of positive philosophers is then simply to institute and develop the intermediate processes which are to connect the two extremes indicated by popular wisdom; and the real superiority of the philosophical spirit over common sense results from its special and continuous application to familiar speculations, duly abstracting them, ascertaining their relations, and then generalizing and co-ordinating them;—this last process being the one in which popular wisdom fails the most, as we see by the ease with which the majority of men entertain incompatible notions. Thus we perceive that positive science is, in fact, the result of a vast general elaboration, both spontaneous and systematic, in which the whole human race has borne its share, led on by the specially contemplative class. The theological view was widely different from this; and it is one of the distinctive characters of the positive philosophy that it implicates the thinking multitude with the scientific few in the general progress, —not only past but future; showing how familiar a social incorporation is reserved for a speculative system which is a simple extension of general wisdom. And here we recognize a fresh evidence that the sociological point of view is the only philosophical one.

Conception of natural laws.

So much has been said about the fundamental principle of sound philosophy being the subjection of all phenomena to invariable laws, that I need advert to it here only because it must occupy its place in the statement of our general conclusions. We have seen how late and partial was the development of the germs of this truth; how the principle was long recognized only in geometrical and numerical subjects, which seemed naturally placed beyond the theological pale that included everything else: how it began to show its value when it made its way into astronomy: how it afforded the intellectual ground of transition from polytheism to monotheism: how it was introduced, by means of alchemy and astrology, into physico-chemical speculations: how scholasticism then took it up, and extended it into a new field by its transient doctrine of a Providence submitting its action to rules: a doctrine which, by its apparent reconciling tendency, has protected the positive principle to this day, while it was spreading through all the provinces of inorganic philosophy, and taking possession at last of the science of Man, with all his intellectual and moral attributes. Here its progress stopped, till I extended it to social phenomena. Some metaphysical speculation there has been about the existence of general laws of society; but their germs have never been brought to light, nor their application to the most common and interesting phenomena been exhibited; but the exposition made in this work leaves no doubt of the universal presence of the principle, the generality of which is in the way henceforth of being proved, both by its philosophical ascendency and its agreement with the general mind, to the satisfaction of all thinking men. Nothing but the protracted influence of monotheistic conceptions could have thus long prevented its universal acceptance amidst the overwhelming evidence of law afforded by the fulfilment of rational human prevision; and now, the nascent discovery of sociological laws will extinguish all remaining opposition by withdrawing its last province from theological explanation, and uniting it with the rest of the empire of human knowledge. While completing and consolidating the great mental revolution begun by the preceding sciences, this sociological recognition of laws perfects the conception of law in all the other provinces, by securing to them that independence in the case of each science which they could not obtain under the supremacy of the mathematical spirit; for, instead of being regarded as an indirect consequence, in the later sciences, of their action in the earlier, and as even growing weaker and more remote, they are suddenly reinforced in importance and dignity by being found in full action in a region inaccessible to mathematical conceptions. The sense of the presence of invariable laws, which first arose in the mathematical province, is fully matured and developed in high sociological speculation, by which it is carried on to universality.

As to the scientific nature of these laws, our ignorance of any thing beyond phenomena compels us to make a distinction which does not at all interfere with our power of prevision under any laws, but which divides them into two classes, for practical use. Our positive method of connecting phenomena is by one or other of two relations,—that of similitude or that of succession,—the mere fact of such resemblance or succession being all that we can pretend to know; and all that we need to know; for this perception comprehends all knowledge, which consists in elucidating something by something else,—in now explaining and now foreseeing certain phenomena by means of the resemblance or sequence of other phenomena. Such prevision applies to past, present, and future alike, consisting as it does simply in knowing events in virtue of their relations, and not by direct observation. This general distinction between the laws of resemblance and those of succession has been employed in this work in the equivalent form of the statical and dynamical study of subjects,—that is, the study of their existence first, and then of their action. This distinction is not due to mathematics, in the geometrical part of which it can not exist. It only begins to be possible in the mechanical portion of mathematics; manifests its character when the study of living bodies is arrived at, and organization and life are separately considered; and finally, is completely established in sociological science, where it attains its full practical use in its correspondence with the ideas of order and of progress.

Logically considered, these laws offer one more distinction, according as their source is experimental or logical. The force and dignity of the laws are in no way affected by the different degrees of credit attached to the modes of ascertaining them. And it is usually a mistake to assign different degrees of credit to two modes of ascertainment which are necessary to each other, and each preferable in some portion or other of the field of knowledge. What the one finds, the other confirms and elucidates; what the one indicates, the other searches for and finds. The positive system requires, on the whole, that deduction should be preferred for special researches, and induction reserved for fundamental laws. The different sciences present varying facilities for the application of the two methods, of which I will only briefly say that they go far to compensate each other. Sociology, for instance, might seem to be too complex for the deductive method, and, at the same time less adapted to the inductive than the simpler sciences which admit of the broadest extension of the positive argumentation: yet through the dependence of the more complex sciences on the simpler, the latter yield *à-priori* considerations to the former, which actually render the greater number of fundamental ideas deductive, which would be inductive in sciences that are more independent. Another consideration is that the more recent sciences, which are the more complex, have the advantage of being born at a more advanced stage of the human mind, when mental habits are improved by a stronger prevalence of the philosophical spirit. Thus, if a comparison were fairly established between the first and last terms of the scale of sciences, I will venture to say, that sociological science, though only established by this book, already rivals mathematical science itself, not in precision and fecundity, but in positivity and rationality. It is more completely emancipated from metaphysical influence: and it is so interconnected as to issue in unity, as I have shown by deducing from a single law the general explanation of each of the successive phases of the human evolution. There is nothing comparable to this in the whole range of the anterior sciences, except the perfect systemization achieved by Lagrange in his theory of equilibrium and motion, with regard to a subject much less difficult and much better prepared: and this proves the natural aptitude of sociology for a more complete co-ordination, notwithstanding its recency and complexity, in virtue simply of its natural position at the close of the encyclopædical scale.

Logical method.

These considerations point out to us the correlative characters which distinguish the positive method of philosophizing,—the logical and the scientific. The first consists in the preponderance of observation over imagination, contrary to the earliest mode of proceeding. We have no longer anything to fear from theological appeals to the imagination: but the metaphysical procedure, which follows neither fictions nor facts, but its own train of entities, is still too attractive to minds which are not sufficiently established in positive practices. It is still necessary to point out that laws are the true subject of investigation, and that the function of imagination in philosophizing is to create or perfect the means of connection between established facts, but not, in any case, to meddle with the point of departure or the direction of the inquiry. Even in the *à-priori* mode of preceding, the general considerations which direct the case have been derived from observation in the science concerned or in some other. To see in order to foresee is the business of science: to foresee everything without having seen anything is only an absurd metaphysical Utopia, which still obtains too much favor. The scientific view which corresponds with this logical one is, that the positive philosophy substitutes the relative for the absolute in the study of qualities. Every inquiry for causes and modes of production involves the tendency to absolute notions; and the tendency therefore existed throughout the theological and metaphysical periods. The greatest of modern metaphysicians, Kant, deserves immortal honor for being the first to attempt an escape from the absolute in

Scientific method.

philosophy, by his conception of a double reality, at once objective and subjective; an effort which shows a just sense of sound philosophy. Placed as he was however between the Cartesian philosophy behind and the positive philosophy in its completion before him, he could not give a truly relative character to his view; and his successors lapsed into the absolute tendencies which he had restrained for a time. Now that the scientific evolution comprehends social speculations, nothing can stop the decay of the absolute philosophy. Inorganic science, presenting the external world, where Man appears only as a spectator of phenomena independent of him, shows that all ideas in that sphere are essentially relative,—as I have before remarked, especially with regard to Weight, for one instance. Biology confirms the testimony by showing, with regard to individual Man, that the mental operations, regarded as vital phenomena, are subject, like all other human phenomena, to the fundamental relation between the organism and its medium, the dualism of which constitutes life, in every sense. Thus, all our knowledge is necessarily relative, on the one hand, to the medium, in as far as it is capable of acting on us, and on the other to the organism, in as far as it is susceptible of that action; so that the inertia of the one or the insensibility of the other at once destroys the continuous reciprocity on which every genuine idea depends. This is especially noticeable in instances in which the communication is of a single kind, as in astronomical philosophy, where ideas cease in the case of dark stars or of blind men. All our speculations, as well as all other phenomena of life, are deeply affected by the external constitution which regulates the mode of action and the internal constitution which determines its personal result, without our being able in any case to assign their respective influences to each class of conditions thus generating our impressions and our ideas. Kant attained to a very imperfect equivalent of this biological conception: but, if it could have been better accomplished, it would have been radically defective, because it relates only to the individual mind; a point of view much too remote from philosophical reality to occasion any decisive revolution. The only natural and sound view was obviously one which should present a dynamical estimate of collective human intelligence, through its whole course of development. This is at length done by the creation of Sociology, on which the entire elimination of the absolute in philosophy now depends. By it, biology is rendered complete and fertile; showing that in the great elementary dualism between the mind and the medium, the first is subjected also to successive phases; and especially disclosing the law of this spontaneous evolution. Thus the statical view showed us merely that our conceptions would be modified if our organization changed, no less than by a change in the medium: but, as the organic change is purely fictitious, we did not get rid of the absolute, as the unchangeableness seemed to remain. But our dynamical theory, on the contrary, considers prominently the gradual development of the intellectual evolution of humanity, which takes place without any transformation of the organism, the continuous influence of which could not have been left out of the inquiry but by the vicious freedom of abstraction that characterizes metaphysical study. This last effort alone, therefore, is thoroughly effectual in destroying the absolute philosophy: and if it were possible that I could be mistaken as to the true law of human development, the only inference would be that we must find a better sociological doctrine; and I shall still have constituted the only method that could lead to positive knowledge of the human mind, regarded henceforth in the whole of its necessary conditions. Mental immutability being thus discarded, the relative philosophy is directly established: for we have been thus led to conceive of successive theories as accelerated approximations toward a reality which can never be rigorously estimated,—the best theory being, at any time, that which best represents the aggregate of corresponding observations, according to the natural course so well understood by scientific minds; to which sociological philosophy adds a complete generalization, and thenceforth a dogmatic sanction.

Stability of opinions.

If there should be any fear for the stability of opinions, under this view, it is enough to point out that, in a statical aspect, however different the universe may appear to any existing and any conceivable order of beings, the foundation of knowledge must be essentially the same in all cases, differing largely in degree, but not in kind. Both the experimental and the logical part of every idea must be of the same sort to all minds, however differing in intensity; and we can not deny the universality of the intellectual laws without denying that of all the other biological laws. The inferior animals know the universe much less than we do, as superior beings might know it much better, by more complete observation and more general reasoning: but in all these cases, the subject of investigation and the basis of conception remain the same, amidst wide differences of degree, such as we see in a small way every day among men of different capacities,—even mental maladies not affecting the case. In a dynamical view, it is clear that the variations in human opinion, according to time and place, do not affect the radical uniformity; for we now know the law of evolution to which these mutations are subject. There never would have been any apprehension about the matter, except for the absolute philosophy which could not conceive of truth apart from immutability: and to this it is owing that modern thinkers of the revolutionary school sever themselves wholly from the past, and regard all ancient opinion as a kind of chronic state of mental alienation without inquiring any more into the reasons of its cessation than into its origin. Our historical survey has shown us that, through successive phases, the human race was advancing toward the fundamental truth to which we ourselves are only approximating, without any hope of attaining it. Sound philosophy interprets to us the progress, analogous to our own, by which the general mind grew up toward maturity, through the same principle of an increasing accordance between observations and conceptions, which now convinces us of the progressive reality of our various positive ideas, since the inquiry into laws prevailed over the search after causes. Such is the relative character of the sociological philosophy,—setting before us the great human evolution, subject to a determinate course; governing at each period aggregate human thought, so as to reconcile the most mutually repugnant systems, by referring each to its corresponding position, without ever compromising the strength of the final decision by any such eclecticism as now aspires to lead the intellectual movement, while itself perpetually oscillating between the absolute and the arbitrary, which it appears equally to admire. The spectacle of dogmatic variations, as exhibited in human history, which is really dangerous to unfortified understandings, is thenceforth converted, by a judicious historical observation, into a direct and permanent source of the firmest and most extensive agreement.

Destination of the Method.

The Individual.

Such is the nature of the positive method. The next inquiry is of its destination,—in regard to the individual, the race, speculative life and practical life. The theoretical office in regard to the individual consists in satisfying the double need of extending and connecting his real knowledge. The connection between our conceptions offered by the old philosophies, hindered their extension by providing beforehand an explanation to suit all imaginable cases; and the consequence would have been a total obstruction of knowledge, but for the secondary questions, pertaining to common affairs, which disclosed the operation of laws, without which Man could not have guided his conduct from hour to hour. From this accessory, special and desultory positivity, genuine investigation proceeded at length, and manifested its aptitude, first to connect our conceptions, and by that very connection to extend them; and then, using every extension to perfect the anterior connection. Though the introduction of new facts may appear to disturb the positive arrangement, all experience proves,—and the experience is now long enough to be relied on,—that the positive method solves all such difficulties by its faithful subordination of conceptions to realities. Meeting these two needs as it meets those of order and progress in social affairs, its function may be simply described as constituting the general harmony of our intellectual system, so as to express the natural pre-eminence of statical over dynamical needs,—those of existence over those of motion, in the case of the race as well as the individual. The relative character of the philosophical spirit exhibits this logical coherence as always constituting the most decisive testimony to the reality of our conceptions, because their correspondence with our observations is thus secured, and we may depend upon being as near the truth as the corresponding state of things allows. Now, as all rational prevision consists in passing regularly from one idea to another, in virtue of their mutual connection, such a prevision is necessarily the most perfect criterion of true positivity,—

manifesting as it does the destination of that fundamental harmony which makes the extension of our knowledge result from its general co-ordination. It is true, the feebleness of the speculative faculties in the human being prevents these intellectual needs from being very prominent; but they are more keenly felt than might be supposed from the patient resignation with which the human mind has endured a philosophical system which affords them no satisfaction; and it is a proof of this that there has never been a time when the introduction of new truth from without has not been hailed with extreme eagerness; an avidity which shows that theological and metaphysical explanations had been put up with merely under the impossibility of obtaining anything better, and without in any degree impairing the cerebral appetite for sound alimentation. The very weakness of our understandings is only another reason for our involuntary predilection for real knowledge,—important as is the comfort to us of reposing on the steadiness and continuity which can not be recognised in single phenomona, and which bring all irksome doubt to a welcome close. Even greater,—immeasurably greater,—is the service rendered to the race by the speculative office which is thus important to the individual; for it constitutes the logical basis of human association It harmonizes the collective in the same way as the individual mind, by means of the same property, though with unequal rapidity in the two cases. The resemblance between the individual and the collective human mind assures us that whatever philosophy constitutes a logical coherence in a single mind may be relied on, for that reason, to bring all thinkers into harmony, sooner or later. It is in this way that great philosophical minds become the intellectual guides of Humanity, undergoing first the mental revolution which they make easier and more speedy to others by its manifestation in themselves. If this oneness of interest was evident amidst the extravagances of former philosophies, it must be complete and irresistible in the positive state,—all minds speculating on a common basis, open to their examination, but untouched by their authority, and proceeding by a homogeneous course from the same starting-point to identical investigations,—their inequality affecting only the date of their success. The inverse action is clear;—that such an inevitable and unanimous concurrence must confirm the reality of the new conceptions, no less than their opportuneness. In another view, no partial intelligence can so separate itself from the general mass as not to be essentially carried on with it,—even if it be—as an extreme case—that of a wise physician compelled to live among madmen, whose vehement convictions inevitably act upon his own. The most profound thinker will therefore never forget that all men must be regarded as coadjutors in discovering truth, as well as in applying it. However nobly bold may be the genius destined to advance the general wisdom, its absolute isolation would be as irrational as immoral. The state of abstraction which is a condition of high intellectual achievements, involves so much danger of error,

The race.

by either negligence or illusion, that every good mind will prize the control of the general reason, steadying and correcting his particular adventurous course, till he shall have established his claim to that general assent which is the object of his labors. This speculative convergence, once obtained, becomes the first elementary condition of true association, which requires a union of concurrent interests, with not only a sufficient conformity of sentiment, but also, and above all, of opinions; this triple foundation being indispensable to practical and durable association, from the household up to the whole human race. The deep-seated hatred always aroused by serious intellectual disagreement, indicates that, notwithstanding the feebleness of our intellectual faculties, any action on them affects the whole of our conduct, and that human association requires, in its highest state, their universal coincidence. I need only point to the disturbances, personal, domestic, and social, occasioned by the old philosophy which once exercised a harmonizing influence, however imperfect, to show the need of the new philosophy, which can alone furnish the basis of true intellectual communion, manifesting a consistence and extension to which the past can afford no parallel. This is the speculative destination of the positive method, for individual and collective Man.

Speculative life.

Whenever, in the course of this work, we have noticed the intellectual needs that relate to practical life, we have found them confirmatory of my view of the positive philosophy. It is as the basis of rational action that science has hitherto been universally prized; and that attribute will never lose any of its value. We have seen throughout how practical needs have generated science in all departments; though the science could not have been thus generated if our mental tendencies had not been favorable to it; since the practical aptitude of positive theories could be discovered only by adequate culture, driving out theological and metaphysical chimeras which made much larger promises. When once the relation of science to practical wants was made clear in a few cases, it became a very effectual stimulus to the philosophical spirit by exposing the impotence of the system of arbitrary wills and entities in directing Man's action upon nature; and the rationality and positivity of our conceptions were proved, to the eminent advantage of lofty scientific speculation, when prevision was made the ground of action, and the humblest practical problems were seen to be connected with the highest theoretical researches; as in the arts which relate to astronomy. Though some few minds find sufficient stimulus to the philosophical labor which is repugnant tc our nature in the need to know phenomena and to connect them, the philosophical discipline would have been considerably retarded if practical exigencies had not afforded a more general instigation. By completing the system of natural philosophy, the creation of sociology must prodigiously extend the relation between speculation and practice, which must henceforth embrace all possible cases. The rational subordination of art to science has

Practical life.

already begun to be organized, however imperfectly, in the natural order of the sciences, beginning with the geometrical and mechanical arts, proceeding through the physico-chemical, and now, in our own time, including the biological, which are concerned with the preservation of health and the treatment of disease. The political art remained unattempted,—its proud severance from all theory whatever being a mere testimony to the radical insufficiency of any theory yet proposed, and being destined to give way whenever the general reason shall perceive that here, as in other departments, phenomena are referred to real natural laws, such as may habitually supply practical guidance. Hence again, as in other cases, philosophy will derive fresh stimulus from its connection with practice, and our knowledge will increase and improve both in positivity and rationality. In thus ascertaining the destination of the positive method, we arrive at a better knowledge of its nature, through the inquiry into the direction of its efforts, and the degree of precision they admit of. In the absence of all guidance, in the earliest days of positivism, its spirit applied itself to everything that came in its way; but the blind instinct must yield, with the progress of science, to philosophical discipline, sanctioned by the popular good sense which is always opposed to a useless expenditure of our intellectual forces. When our theoretical labors are duly organized, the highest scientific and philosophical minds will be at command, to give their attention to the great subjects of the period, instead of being wasted as they are at this day; and the limit of research will be fixed no less indisputably than its kind, from its being ascertained to what point the natural laws, which are the real object of study, are compatible with detail in investigation. We find in various cases, and especially in astronomy, that sound theory can not successfully transcend the precision demanded by practical needs,—a purposeless inquisition being too likely to end in destroying laws already established, without any substitution of new guidance.

Liberty of method.

One more suggestion remains, with regard to the destination of the positive method; that, from its relative spirit, it determines the kind of liberty of option left to our understandings in the formation of conceptions, as long as we respect the reality of external laws. In the construction of scientific works, we may give them the most suitable form, as we would in the æsthetic province. There are two kinds of cases to be considered in each department of research; those which are, though of a positive nature, indefinitely inaccessible, and those which are simply premature, but on which it is of consequence to us to have some kind of opinion, as a basis for speculation. In the first class are included questions, arising in every province of natural philosophy, which our reason can never solve, but which may yet be regarded as positive, because it is conceivable that they would be manageable by a better organized intelligence, qualified for a more complete investigation and more powerful deductions. In such a case, we may select such artifices as are suggested by the genius of the science concerned, with due care that they shall aid, and not impede, the accretion of real knowledge. Of this kind is the hypothesis spontaneously adopted in physics, relative to the molecular constitution of bodies; and the device of dualism which I suggested in chemistry, in aid of the higher speculations of the science. In the second case, it is only necessary to apply the theory of hypotheses, sufficiently treated of in connection with physics; and which, when duly applied to practice without abuse, can not but improve the cultivation of genuine knowledge. Thus we find the philosophical view of the study of natural laws to be, that that study represents to us the external world, by satisfying the essential inclinations of our reason, as far as is allowed by the precision prescribed by our practical needs. Our statical laws correspond to this instinctive predilection for order and agreement; and our dynamical laws accord with our irresistible tendency to believe in the perpetuity of any return once established.

We have now only to consider the institution and gradual development of the positive method.

Extension of the method.

The whole procedure of our reason affords promise that the positive philosophy will, in course of time, comprehend all subjects of human thought; not only science, but art,—æsthetic and technical. Yet, while keeping this prospect in view, we must abide by the double preparatory division which has thus far existed;—between speculation and practice first; and then between scientific and æsthetic contemplation. We have seen that these divisions date from the polytheistic period; the first becoming visible under the theocratic phase, and the other under the Greek system; and both having persisted to this day, notwithstanding the growing importance of their mutual relations. In all the six provinces of knowledge, we find the first condition of mental progress to be the independence of theory, as no conceptions could have been formed if the theoretical point of view had been inseparable from the practical. We see too how both must have entire freedom,—the theoretical spirit to retire into its condition of analytical abstraction, and the practical to occupy itself with specialities. If either repressed the other, the consequences would be fatal to progress: the practical supremacy would extinguish those tendencies which are already too weak; and the theoretical would exclude reality by preventing any practical operation from being completed. Our mental habits, generated by the old philosophy, induce us to exaggerate the value of *à priori* considerations. They are very efficacious if wisely instituted and conducted; but the first condition of their utility is, that they should be applied by the practical spirit in each concrete case, the scientific data being merely comprehended among the elements of the special combination employed. Any greater subordination of the practical to the theoretical than this, could lead to nothing but hopeless disturbance. The nature of modern civilization tends to obviate such disturbance, by establishing the division in more and more clearness;

and now the sociological spirit entirely consolidates it, by extending it to political conditions, in the way that we have seen. The division between the two kinds of contemplation,—the scientific and the æsthetic,—is much less disputed, though it is less marked. Even when imagination ruled in philosophy, the poetical spirit, in its utmost freedom, always recognised its subordination to the philosophical spirit, through the fundamental relation which connects the sense of the beautiful with the knowledge of the true, and thereby subjects the ideality of Art to the collective conditions of scientific reality. As reorganization proceeds, their combination will become closer, and especially in practical life,—Art affording to Science, in return for a secure basis, not only intellectual solace and moral stimulus, but much reactive aid in perfecting its philosophical character. Under a relative philosophy, Art may be employed as it could not be under an absolute system, in facilitating scientific expression, and even suggesting modes of scientific pursuit. Whatever may be the ulterior value of such a connection, the distinction between the two kinds of contemplation will always be radical, and the more abstract and general will always govern the less.

Abstract and concrete Science.

A more modern, but wholly indispensable division remains to be noticed; that between abstract and concrete science, as established by me through the whole course of this Work. Bacon was the first who saw (and he but indistinctly) that what he called the first First Philosophy (because it must form the basis of the whole intellectual system) could result only from an abstract and analytical study of the elementary phenomena which, in varied combination, constitute the existence of natural beings, for the purpose of ascertaining the laws proper to each order of incidents, considered directly and apart from the beings which manifest it. From no clear and express understanding of this distinction, but merely because it was impossible to proceed otherwise, scientific progress has been guided by it for two centuries past: for, as we have seen throughout, concrete science, or natural history, properly so called, could not be even undertaken till abstract science was instituted in regard to all the orders of elementary phenomena concerned; every concrete inquiry involving the combination of the two. Now, it is only in this work, which first constitutes the final and most important science, that the condition has been fulfilled; and it is therefore not surprising that the great scientific speculations between Bacon's time and ours have been of an abstract character,—the concrete speculations during the same interval having been necessarily impotent: nor can such a forced and empirical observance of the Baconian precept preclude the necessity of the demonstration which discloses the full bearings of the suggestion. Though the creation of Sociology, by completing and systemizing the first philosophy, must soon insure an adequate treatment of concrete questions, it is not the less important to remember that the institution of the positive method must for ever rest upon the division, without which the two already pointed out would be altogether insufficient. This division constitutes in fact the most powerful and delicate of all the general devices required by the speculative working out of the positive system. The simplest, most general, and highest point of view attainable by the philosophical spirit has been reached by a gradual process of abstraction, discarding first practical requirements, then æsthetic impressions, and finally, concrete conditions: and if this last, founded on the same logical grounds as the others, had not accrued to complete their efficacy the positive philosophy could not have yet existed. In the simplest cases, even those of astronomical phenomena, we have seen that no general law could be established, while bodies were considered in their collective concrete existence, from which it was necessary to detach the leading phenomenon, and then to subject it to abstract examination, which, again, might react on the study of the most complex realities. The grand application of this logical precept is however in the case of sociological theories, from their extreme complexity; and in this province we see what rationality has been established, amidst all the dangers arising from a mass of unorganized learning, by my having put aside all concrete disturbance, in order to seize, in its simplicity, the law of human movement, leaving all apparent anomalies to be reduced to principle afterward, as in the astronomical case. The maintenance of the division is necessary here for the same reasons as in regard to the two others, under penalty of lapse into such confused views and desultory speculations as we have with so much difficulty escaped from: and if this seems to remove the theoretical view too far from the practical, there will be a compensation in a superior generality, testifying to the necessity of the political and philosophical separation recommended in the last chapter as the basis of modern reorganization.

These are the three stages of successive abstraction, the combination of which determines the gradual institution of the positive method, in a spontaneous manner at first, and afterward systematically. As the method is neither more nor less than a philosophical extension of popular wisdom to abstract speculation, it is clear that its basis, corresponding with that of common sense, admits of no useful dogmatic explanation. If on this ground we decline looking for such dogmatic explanation of the lowest subjects of speculation, —of which all we can say is that our ideas are spontaneous and universal—much more must we abstain from such barren and vicious systemizing in logical researches, properly so called. Thus are the logical and scientific points of view to be finally regarded as correlative and indivisible aspects of each positive theory, neither being in reality more susceptible then the other of an abstract and general appreciation, independent of any determinate manifestation. Thus they have been treated throughout this work, in which the logical training has always co-existed with the scientific, and their connection being such that the scientific results of one science have often been found to be the logical resources of another; a fact which shows the impossibility of separating them.

Relations of phases.

Thus have we ascertained the composition of the positive method: and we have only further to mark out the systematic co-ordination of the chief successive phases which it has naturally presented.

Mathematics

No irrational exaggeration of the claims of Mathematics can ever deprive that part of philosophy of the property of being the natural basis of all logical education, through its simplicity, abstractness, generality, and freedom from disturbance by human passion. There, and there alone, we find in full development the art of reasoning, all the resources of which, from the most spontaneous to the most sublime, are continually applied with far more variety and fruitfulness than elsewhere; whereas, the art of observation, though there receiving its first scientific application, is scarcely traceable, even in mechanics. The more abstract portion of mathematics may in fact be regarded as an immense repository of logical resources, ready for use in scientific deduction and co-ordination: yet, as the human mind is indisposed to the most abstract speculation, it is geometry, rather than analysis, that will always be, in a logical view, the chief of the three branches of mathematics, and the fittest for the first elaboration of the positive method. When Descartes chose geometry for the ground of his organization of the relation of the abstract to the concrete, he made it the centre of mathematical conceptions, as analysis found there vast material and a noble application, in return for the generality which it imparted. Mechanics, on the contrary, though yet more important than geometry, in a scientific view, has by no means the same logical value, on account of its greater complexity; and the obligations of analysis to it are but secondary and indirect. In passing from geometrical to dynamical speculations, we feel how near we are to the limits of the mathematical province, from the extreme difficulty of treating the simplest questions in a thoroughly satisfactory manner.—We have seen abundant reasons, in the course of our survey, why the mind that confines itself within the mathematical province is subject to a variety of fatal snares, and very ill prepared for the loftiest aims of human reason. Without recapitulating the faults and errors arising from the misuse of the mathematical spirit, it is enough to say that when a sound philosophy prevails, it will be felt that the first phase of positive logic not only can not dispense with those which follow, but must look to them for much reactive assistance from their combination, without which mathematical logic itself can not be completely understood and valued.

Astronomy.

These considerations show us the value of the next phase, the astronomical, in which the positive method obtains a second degree of development, in the closest connection with the first. It is overlaid, as we have seen, with mathematical ideas and procedures; but, discarding these as far as possible, we shall find that the distinction, logical and scientific, between this phase and the last is much greater than is commonly supposed. In geometry, the disproportion between the observation employed and the consequences obtained is so great as to render the function of observation almost inappreciable: whereas, in astronomy it is distinct and direct. Here, as the simplest and most general of the four resources for obtaining knowledge, it shows what may be done, in the most unfavorable situation, by a single sense in ascertaining the most intellectual kind of truth. Not less striking is the intervention of the logical processes which here guide an investigation singularly indirect: and thus if, in a scientific view, astronomy is fairly regarded as the most fundamental part of the system of inorganic knowledge, it is no less, in a logical view, the most perfect type of the general study of nature. Here men learned to modify the earliest philosophy by conceptions derived from the study of the external world; and here we find the fittest dogmatic exposition of rational positivity. Here, throughout all time, will be found the first philosophical sense of natural law; and here may be learned what is meant by the explanation of any phenomenon, by means of resemblance or connection. The whole of its historical and dogmatic course discloses the agreement between our conceptions and our observations which is the essential character of real knowledge. It yields us the true theory of scientific hypotheses; and it proves that its rationality is not less satisfactory than its positivity, by offering the first and most perfect example,—thus far indeed the only one, of that rigorous philosophical unity which must be kept in view in every order of speculation. No other science, again, has so familiarly manifested that rational prevision which is the most marked characteristic of positive theory. Its imperfections proceed from a want of definiteness in the circumscription of the objects and the subjects of its researches; an imperfection which time will cure. Meanwhile it appears that, contrary to popular notions, the astronomical phase is a stage in advance of the mathematical, in all essential logical respects, and much nearer the true philosophical condition.

Physics and Chemistry.

For logical purposes, we may combine physics and chemistry, though for scientific examination they must be separated. The only logical feature of chemistry is its art of systematic nomenclature: otherwise, it merely applies, in a less perfect way, the general method of investigation developed by physics. In combination, these two sciences form the bond between the two extremes, logically and scientifically: on the one hand completing the study of the universe, and preparing for that of Humanity, and, on the other, exhibiting an intermediate complexity of subject, and corresponding to a medium state of positive investigation. They require all foregoing resources for investigation, and present a new mode of observing. In physics, the experimental method takes its rise; and it is immediately attended by the logical resource of the corpuscular or atomic theory; both being limited to the same kind of investigations. When the logical and scientific conditions proper to the position in the scale are fulfilled, there can be no doubt that this third phase of rational positivity will be found to be as superior to the astronomical phase as that is to the mathematical, imperfect as it now is in its oscillation between a barren empiricism and an oppressive mysticism, metaphysical or algebraic. The varied and complex nature of such an order of investigations could not admit, even under a better intellectual system, of a precision and co-ordination comparable to those permitted by celestial theories; but these imperfections, transient or permanent, do not prevent the sense of natural law from receiving here a considerable extension, by being applied to the most complex phenomena of inorganic existence.

Biology.

The next step is from inert to living nature: and we see the positive method rising to a new application much more different from the three former than they are from each other, and which will make this new science as essentially superior to the preceding by its logical plenitude as by its scientific importance, when its conditions are thoroughly understood. Thus far, investigations have permitted and required an almost indefinite parcelling out; but the interconnection of biological phenomena is such that no analytical operation can be conceived of otherwise than as introductory to a synthetical determination,—the division between the abstract and the concrete being all the while maintained, and the more carefully on account of the small interval that separates them. A radical change in the scientific system now therefore enters in, making the spirit of generality overrule the spirit of detail, till then preponderant, and thus carrying forward our reason remarkably toward its true natural condition. The statical view now comes out clearly in connection with the dynamical, in a manner especially suitable to biological speculations, in which these two kinds of estimate appear more distinct and correlative than in any former application. But the grand feature of this fourth phase is the vast extension of the general Art of observing, then augmented by the institution of the comparative method, hitherto very subordinate and obscure, but now proved to be the most powerful logical instrument applicable to such speculations. Corresponding with it, and summing up its results, we have, under the same phase, the theory of classification. The logical condition of the phase ought to be judged of by this double creation, and not by its existing imperfection, which is owing to its more recent formation, its higher complexity, and an inferior fulfilment of the preparatory conditions of its rational culture. The sense of natural law must arise out of inorganic research; but it could not acquire its full efficacy till it was extended to biological speculations, which are above all adapted to discredit absolute notions by exhibiting the immense variety of modes of existence. Great as is the advance attained in this phase, it remains no less merely introductory than the rest, though holding a higher place. Its insufficiency becomes broadly apparent when we advance from the study of the organic life, by which it is least separated from the foregoing sciences, to the study of animality; for then, in applying ourselves to the highest positive speculations, in contemplating the moral and intellectual functions of the brain, we become at once sensible of the irrationality of such a scientific constitution: for the most decisive case of all can not be understood but by subordinating the study of it to the ulterior science of social development, for the reasons already assigned to show the impossibility of understanding our mental nature from the individual point of view; a method which must be unproductive in whatever way it is instituted.

Sociology.

In every view, social science offers the attributes of a completion of the positive method. All the others even that of Man, are preparatory to it. Here alone can the general sense of natural law be decisively developed, by eliminating for ever arbitrary wills and chimerical entities, in the most difficult case of all. The old philosophy must be doomed to extinction, when a regular study is able to disclose the laws of the continuous variation of human opinions. I have repeatedly said that this science permits, above any other, the prominent use of *à priori* considerations, both from its position in the hierarchy, by which it depends on all the rest, and in virtue of the perfect unity which is given to it by its plenitude of logical resources. It will soon be admitted to be the most logical of all the sciences, considering the degree of precision compatible with the nature of the phenomena, since the most difficult and varied speculations are naturally connected with one single fundamental theory. But the most striking feature to us is the extension of the means of investigation required by, and involved in, this most complex subject of human study. It enjoys all the resources of the anterior sciences; but they would be almost useless, and even deceptive, without the addition of the historical method, properly so called, which investigates, not by comparison, but by gradual filiation. We have reviewed this method in its dogmatic form, and in its application, and we have seen how it must preponderate over all other resources, so as to bring out and utilize the properties of positive investigation, by which the regular action of human faculties is to be perfected. Thus a universal logical method corresponds in this case to a universal scientific view; and the result is that the human mind here finds its natural position. It would occupy too much space to exhibit the reaction of this science upon those that precede it; and it would be as yet premature. I have done what I proposed, in constituting the true system of positive philosophy, as a result of the preparation instituted by Bacon and Descartes; and its practical construction is a work for a future time,—probably near at hand.

These are the five phases of the positive method, through whose succession the scientific spirit rises gradually to the dignity of the philosophical spirit, effacing at length the provisional distinction between them which had been necessary during the earlier part of the human evolution. If we consider the miserable theoretical state from which human reason set out, we shall not wonder that so long a tutelage was required to enable Man to extend to his abstract and general speculations the same mental training that popular wisdom spontaneously employs in its partial and practical acts. Though there can be no exemption from the necessity of reproducing this natural succession for ever, the systematic education now prepared for, in place of the instinctive, will render the process much more rapid and easy; and I rejoice in the privilege of having prepared it for my successors, by the elaboration of this my original scheme.

In this chapter, I have wrought out the most difficult and important part of my work, in as far as it relates to our general conclusions, according to the constant preponderance of our logical over our scientific needs; and especially at a time when, the doctrine being in a backward state, the philosophical procedure must consist in instituting the Method completely. What I have done in this direction must be considered as a natural equivalent of the discourse of Descartes on method, allowing for the diversities resulting from the new situation of modern mind, and the new corresponding wants. Descartes had for his subject the introductory evolution which had been for two centuries preparing for the ascendency of rational positivism; while I have had to examine the fulfilment of that preparation, in order to determine the final constitution of a sound philosophy in connection with social objects,—a view which Descartes avoided, but which Bacon already anticipated. This most difficult part of my task being achieved, I have only to complete my object by making a rapid scientific survey, to answer to the logical, and to venture upon an anticipation of the action of the positive philosophy, when it shall have attained its full maturity.

CHAPTER XIV.

ESTIMATE OF THE RESULTS OF POSITIVE DOCTRINE IN ITS PREPARATORY STAGE.

As I have intimated, our scientific conclusions can not be so important or so extensive as our logical conclusions, because they relate to a system of knowledge scarcely yet instituted: yet it is necessary to follow up the logical summary with a sketch of the proper nature and connection of the abstract studies that we have examined in succession; our present view regarding them as so many necessary elements of a single body of doctrine, according to our principle.

We have perceived throughout that, in the case of the human evolution at least, there exists a natural agreement between our knowledge and our needs. The knowledge which is inaccessible to us is precisely that which could answer no purpose but gratifying a vain curiosity. We have no concern with anything but the laws of phenomena which affect human beings; such action, however indirect, constituting a basis of positive estimate, the full realization of which can follow only very remotely the manifestation of the corresponding needs, at any rate till we can institute a better research. This scheme must comprehend, on the one hand, Humanity itself, in its existence and action; and, on the other hand, the general medium, whose permanent influence is an essential element in the whole movement. Every scientific, as well as logical consideration, shows the necessity of the study of the medium; and thus naturally divides science into the two departments,—inorganic and organic science; the first being the indispensable preparation for the second; and the second simply modifying the phenomena of the first by a nobler action. The three essential modes of the first order—the mathematical, physical, and chemical, and the two which are proper to organic existence—the individual and the social, thus present a scientific series precisely correspondent to the logical that we have just reviewed; and its five stages will, in like manner, lead us up to the normal state of true philosophy.

The Mathematical element.

Mathematical existence is the simplest and most universal of all; and, in a geometrical form first, and then a mechanical, is the only kind of existence cognizable by us in the many and important cases in which our investigation can proceed only on visual evidence. This is the scientific ground of the priority of the mathematical element in positive philosophy; and scientifically speaking, the only great result derivable from it is a systematic development of the sense of logical laws, without which physical laws could not be conceived of. Thus, numerical speculations, the source of the logical instrument of analysis, have historically furnished the earliest manifestation of ideas of order and harmony, gradually extended afterward to the most complex subjects. Apart from that, mathematical science evidently consists especially in geometry and mechanics, answering to our primitive notions of existence and action; for, in the statical case, all phenomena are reducible to relations of magnitude, form, or position; and, in the dynamical case, to mere movement, partial or general. Such a simplification is practically inconvenient, and may be misleading, as the encroachments of geometers plainly show: but it is true in an abstract sense; and therefore universally true, whatever other conditions may be added in cases of growing complexity. Geometry, too, is more general than mechanics; for we can conceive of existence without motion; as in the case of stationary stars, which come under only geometrical conditions; and to geometry we owe the earliest conception of laws of agreement, which may be regarded quite apart from those of succession. Yet, in a scientific sense, Mechanics in the more important branch of mathematics, on account of its more direct and complete relations with the rest of natural philosophy; and on account also of the implication of mechanical speculations with geometrical considerations; a drawback upon their logical perfection, but a source of marked reality, enabling them to represent the whole of mathematical existence. This introduction to natural philosophy, with its astronomical manifestation, is, we know, the only portion of inorganic science which has attained its full normal constitution; and for this reason I hold it extremely important to show the coincidence between the primary laws on which this constitution depends, and the laws which seem to be proper to organic existence; that we may perceive by the direct correlativeness of the two extreme cases, the tendency of all our knowledge to scientific unity, corresponding to the logical unity already recognised. The intermediate ideas,—those of the physico-chemical order,—will no doubt add their confirmation when they shall have become rationally established.

Application to Sociology.

I have shown that the physical laws which are the basis of the theory of motion and equilibrium, and therefore all their consequences, are as applicable to the mechanical phenomena of living bodies as to any others (allowing for the difficulties arising from a complication of details); and we have seen, in a more special manner, that the study of animal mechanics, in the province of biology, must begin with such an application, and would be wholly unintelligible without it; but we have now to go much further, showing that the application must extend even to the social form of existence. As to the first of these laws, Kepler's law of inertia, improperly so called,—seen in its true light as the law of mechanical persistence,—is merely a particular case of the tendency of all natural phenomena to persevere in their state, unless disturbed; a tendency specially established with regard to the most simple and general phenomena. I have traced back the biological case of Habit to this principle, modified only by the characteristic intermittence of the corresponding phenomena. In social life, less rapid and more durable than individual life, we see an analogous exemplification in the obstinate tendency of every political system to perpetuate itself. In physics, again, we have noticed, in acoustics, phenomena which prove that, in the smallest molecular changes, there is a disposition to the reproduction of acts which were before supposed proper to living beings, and which evidently come under the law of mechanical persistence. It is impossible to deny here the subordination of all natural effects to some universal laws, modified according to the conditions of each case. It is the same with the second law of motion,—Galileo's law of the reconciliation of any common motion with various particular motions,—which is extensible to all phenomena, inorganic and organic,—all active and passive mutual relations being radically independent of any action which is precisely common to the parts concerned. In biology, we find this true in the cases of sensibility and contractility: for, our impressions being purely comparative, our appreciation of partial differences is not interfered with by any general and uniform influence. In sociology, we find it again; any disturbance in the interior of any political system being due to the unequal progressive action on the different parts which, if participating in the movement in any equal degree, would be unaffected by a much more rapid progression. We discern an analogous case in the physico-chemical province, in thermometrical effects referrible to mutual inequality, and we shall no doubt encounter many more when the science is further developed. As to the third law of motion,—Newton's law of the equivalence of action and reaction,—its universality is more striking than in the other two cases; and it is the only case of the three in which the principle has hitherto been perceived and proposed. If we adapt our observation to the spirit of the corresponding phenomena, there is no doubt that the equivalence of action and reaction may be as really observed with regard to physical, chemical, biological, and social effects as in the case of mechanical effects. Besides the mutual quality inherent in all actions, it is certain that the general estimate of mechanical reaction, in the combination of masses and velocities, everywhere meets with an analogous appreciation. If Berthollet has shown the chemical influence of mass, before misconceived, an equivalent discussion would manifest no less clearly its biological or political influence. The close and prevalent interconnection which distinguishes vital, and yet more social phenomena, and in which all aspects are mutually dependent, is eminently fit to familiarize us with the universality of this third law of motion. Each of the three laws on which rational Mechanics is founded is, in fact, only a mechanical manifestation of a general law, applicable to all possible phenomena. In order to illustrate this most important approximation, it must be extended, further, to the famous general principle by which D'Alembert completely connected questions of motions with questions of equilibrium. Whether it is regarded, as I propose, as a happy generalization of the third law of motion, or is still regarded as a distinct idea, it is in conformity with a universal conception by which the dynamical is always connected with the statical appreciation,—the laws of harmony being always maintained in the midst of the laws of succession. Sociology here again affords us the most decisive exemplification (though often only implicit) of this general relation; because the two aspects are more marked and more interconnected than in any other case. If we could thoroughly know the laws of existence, I have no doubt that we should find them all, as in mechanics to be mere questions of action. But, though we must proceed in an inverse manner, we proceed upon the same conception of the necessary convergence between the statical and the dynamical conclusions. It is only that the universal principle is employed in a new mode, in conformity with the nature of the phenomena; of which sociological speculation has often presented important examples. The laws of rational mechanics are then only the earliest philosophical manifestation of certain general laws, necessarily applicable to the natural economy of any kind of phenomena whatever. Though they must first be recognised in regard to the simplest and most general case of all, it does not follow that they are due to the mathematical spirit, which at present is the chief obstacle in the way of their being understood. The conception results from the first scientific reaction of the positive spirit proper to organic studies, and sociological speculation particularly, on fundamental ideas which have hitherto seemed proper to inorganic researches. Its philosophical value lies in its establishing an identity between the primary laws of the two extreme orders of natural phenomena: and the delineation I have now offered is intended to point out here, in the only case compatible with the extreme imperfection of science, the first type of the new character of universality which must belong to the chief positive ideas under the natural ascendency of the true philosophical spirit. We have no equivalent case at our command: and in more complex subjects, these general laws can only go a part of the way in directing our speculations; though they will always afford valuable scientific guidance and suggestion, because they must always govern more special laws, relating to other abstract modes of existence and activity. Whether, as we may hope, these more special laws may in time obtain universality among their respective phenomena or not, we are now authorized in conceiving the whole system of our knowledge as susceptible, in certain respects, of a true scientific unity, independently of the logical unity, though in complete agreement with it.

The Astronomical element.

If Mathematics furnishes us with the laws of inorganic existence, Astronomy discloses to us the medium, which is no less universal. Our examination of it may appear a departure from the great Baconian precept about the abstract nature of the speculations proper to the first philosophy: astronomical ideas being in fact nothing else than mathematical notions restricted to the case of the stars. But, true as this is, there is another view,—the same as that which justified the incorporation of the analysis of air and water with abstract chemistry;—that our study is not concrete, inasmuch as it relates to the general medium, which is truly abstract and unchangeable. The mathematical phenomena of astronomy remain abstract, as if the bodies they relate to could admit of no other; whereas the character of a concrete theory consists in the direct and permanent combination of the different modes inherent in each total existence. In astronomy, mathematical speculations do not lose their abstract nature and only exhibit it in a case so important that we are compelled to make it special: its difficulties also constituting the chief destination of mathematical research, as well as its best logical instigation. The reaction on mathematics, again, affords us the most striking evidence of the reality and the scope of its conception. Here, again, the human mind obtains its first systematic sense of a necessary economy, arising from invariable relations proper to corresponding phenomena, and affording, by its inaccessible sway, a rule of conduct. This is the source of the philosophical guidance of collective Man which is carried out by training in the case of individual Man. Yet, the human point of view must prevail in this case, to secure the rationality of the corresponding studies; because our radical ignorance of cosmical laws and our restriction to our own system, prevent our obtaining any external view of astronomical science. We find in astronomy the first instance of the encroachments of the mathematical spirit in an empirical way; but, as we have seen, the fault affects only the logical administration, and does not produce the scientific dangers which it occasions in the more complex departments, because it is in full conformity with the nature of astronomical research.

The Physical.

In Physics, a new action is first recognised, more compound and essentially modifying the simpler. All physical phenomena are common to all bodies; but their manifestation requires a concurrence of circumstances, more or less compound, and not continuous. Of the five physical categories, Weight alone presents a really mathematical generality, thus being the natural transition between astronomy and physics. The others exhibit an increasing speciality, by which I have classed them. The importance of this province, in connection with that of chemistry, will appear if we try to imagine that such a transition from the mathematical to the organic sciences did not exist: for we shall see how all conception of unity must disappear if science consisted of two elements so heterogeneous, which could admit of no permanent relation; even supposing that the positive spirit could arise at all. This intermediate element is so connected with the others at each extremity as to constitute a sufficiently perfect scale. Some difficulties however arise out of this position, which will always largely affect the inherent imperfections of the duplicate science, the subject of which presents neither the simplicity of the first couple nor the characteristic interconnection of the last. We have seen how little prospect there is of scientific unity among the heterogeneous parts of which physics is composed; and the greater probability is that the number of irreducible elements will hereafter be increased; for the diversity must correspond not only with the subjects studied, but with our organic means of investigation. Of the five existing subjects, two address themselves to one sense each,—one to hearing and another to sight; and these can never be made to coincide. The other three relate equally to sight and touch: and yet no one will venture to regard thermology and electrology, as susceptible of fusion with barology, or with each other, however indisputable are certain relations between them. Moreover, the actual number of our external senses is by no means finally ascertained,—so immature is at present the whole theory of sensation. A truly rational inquiry would, no doubt, show that we have two senses relating to temperature and pressure, which are both now confounded with that of touch, which seems to include all the offices whose special seat is not clearly determined. It is evident, again, that smell and taste, largely needed in chemistry, have no function in physics; yet it seems that each of them must have ere this constituted a department for itself, like sight and hearing, if our organization had been in this respect as perfect as that of many of the higher animals. The mode of inorganic existence which is disclosed by smell, seems in fact to be not less distinct from those which correspond to the other senses than they are from each other; of which the persistence and power of the sense through the whole animal series is an evidence. Our organic imperfection may perhaps be to a certain degree compensated by an artificial investigation, which may afford some scientific extension; and an improvement of our relations with the higher animals may conduce to the same end. Meantime, it is clear that the number of irreducible elements that constitute Physics, is not yet even rationally fixed. Till it can be, the science remains peculiarly liable to the encroachments of mathematical and metaphysical abuse. The imperfections of its nature and method of culture, however, cast no doubt upon its rank in the scale of sciences. That rank is settled by the universal principle of decreasing generality; and the principle obviates the worst inconveniences of the multiple character of physics by instituting a gradual transition from the barological speculations which unite it to astronomy, and the electrological which border upon chemistry.

The Chemical.

As for Chemistry, considered separately, it relates to so intimate and complete a mode of inorganic existence, that it has been found difficult to separate it from the organic. The phenomena of various substances present differences which are not reducible, as in the physical case, to inequalities of degree; and here we find fully developed the tendency of phenomena to become susceptible of modification in proportion to their complexity and increasing speciality. That tendency, it is true, showed itself in physics, so as to originate the art of experimentation; but it is far more complete in chemistry, inasmuch as it extends to molecular composition itself: and as such modification could not take place in vital cases without being liable to suspend or suppress phenomena of greater delicacy, chemistry will be always, and more and more, the chief basis of our material power. In a speculative view, chemistry is of extreme scientific importance, as revealing the most intimate mode of inorganic existence, and as completing our knowledge of the general medium in its direct influence on the organism; thus being, with physics, but in a more marked way, the link between inorganic and organic speculation. In regard to interconnection, too, is so superior to physics as to approach very near to biology: and from biology it will, no doubt, hereafter derive some of the collective spirit in which, with physics, it is now very deficient. I have before pointed out the comparative method and the taxonomical theory as probable agencies for perfecting chemical speculation in this way. Here, then, we find the limit of the ascendency of the analytical system, and the natural beginning of that of the synthetical. Meantime, the science is remarkably open to abusive encroachment, and to spoliation by dispersive treatment. It requires protection from encroachment, not only from mathematics, from which physics in a certain degree protects it, but from physics itself. As some scientific men see in physics only geometry and mechanics, others see in the best-marked phenomena of chemistry nothing more than physical effects; a mistake the more hostile to chemical progression, that it rests in part upon the incontestable affinity of the two sciences. But whatever may be the logical and scientific imperfection of chemistry, in which prevision is scarcely possible in even secondary particulars, the sense of natural law, extended to the most complex phenomena of inorganic existence, is not the less strikingly and permanently developed. Thus then we survey as a whole the preparatory science of dead nature, from its astronomical beginning to its chemical conclusion, with physics for the link between the two.

The Biological. Till biological science arose, the logical evolution required that the human mind should be occupied with inorganic science, which, from its superior simplicity, must constitute the basis of knowledge, from which alone rational positivity could arise; and till the positive spirit was extended to social phenomena, biology could not but suffer from the disturbance introduced into it from the anterior sciences. Biologists then have every reason to be grateful to sociology, as a protecting influence against the oppressive, though antagonistic pretensions of the physicists and the metaphysicians. Organic science marks out its own division into two parts,—the science of individual and of collective life: but human considerations are preponderant in both; and, while sociology is based on biology, it reacts upon it: first learning from it to understand the agent of its own phenomena, and then ascertaining the social medium, and exhibiting the course of human progression. The great misfortune of biology has been that, because its phenomena partake largely of the characteristics of the foregoing sciences, it has been extremely difficult to ascertain the nature and extent of the vast accession to material existence which takes place on the institution of vitality, and therefore to introduce the positive spirit into this order of researches. The theological or metaphysical spirit seemed for long the only protection against the intrusion of the inorganic spirit; and how such protection must compromise the scientific spirit, I need not stop to prove. The situation produced by the necessary resistance of modern reason to the old system was curiously exemplified by the opposition of biological doctrine to obvious facts, as in the case of Descartes' theory of the automatism of brutes, which held its ground for above a century, and was in some degree adopted by Buffon himself, though his own contemplations must have shown him its absurdity. He was sensible of the danger of mathematical usurpation in science; but he preferred it to theologico-metaphysical tutelage, which was then the only alternative. We have seen how the difficulty was solved by Bichat's two great conceptions;—the one, physiological and dynamical, distinguishing the organic or vegetative from the animal life,—a distinction which forms the basis of sound biological philosophy; and the other, anatomical and statical, the great theory of elementary tissues, which is in biology the philosphical equivalent of the molecular theory in physico-chemistry. This statical conception is contributory to the dynamical by enabling us to assign a special seat to each of the two kinds of life. Bichat did not contemplate the extension of his theory beyond man: but, confined to the most complex case, it could never have become really rational. We owe the power of extending it, and therefore of establishing the rationality of the science, to the comparative method, which discloses to us the gradual succession of the degrees of organization or life. Lamarck, Oken, and De Blainville, have given us possession of this chief logical instrument of the science, which is also the preponderant idea of all lofty biological contemplation, because the anatomical and physiological aspects there coalesce with the taxonomical. The consideration of the medium was once everything: but here the consideration of the organism rises more and more through the long series of vital systems of growing complexity. Ideas of order and harmony were originated by inorganic studies; but their highest manifestation, in the form of classification and a hierarchy, could issue only from biological science, whence it was to extend to social science. At present, little more is done in biology than assigning the position of its different questions; and the chasms between them are many and wide: but the science has assumed its due character of generality in the hands of its most eminent interpreters; and its scientific constitution is as rational as that of any of its predecessors: but that it is not yet complete is proved by the continuance of the controversy between the theologico-metaphysical school on the one hand, and the physico-chemical school on the other, and by the difficulties still encountered by the great conception of vital spontaneity being developed, in determinate degrees, within the limits of the laws of universal existence. One remedy will be found in such an education as will enable biologists to apply the truths of other sciences to their own, without admitting intrusion from either restricted science or false philosophy: but the intervention of sociology is also necessary,—the last biological degree, the intellectual and moral life, bordering so closely as it does upon the social. The smallness of the results yet obtained from the admirable conception of Gall is owing to the insufficiency of the individual, that is, the biological, view of Man: and the best conceptions of the science can never acquire complete efficacy, or even stability, till they are attached to the basis of social science. Thus only can they be safe from the prolonged dominion of the old philosophy on the one hand, and from the usurpations of the mathematical spirit on the other, in the physico-chemical form; and thus alone can the same conception, in biology as in social science, fulfil the conditions at once of order and of progress.

The Sociological.

The accession of real existence then, occasioned by its extension from the individual to the collective organism, is the originating cause of the only science which can be final. If the definitive complexity is of a different kind from the three preceding, it is quite as indisputable. It is as evident as the implication of the mathematical with the physical; the physical with the chemical; and the chemical with the biological: and it also accords with the decreasing generality of successive phenomena. The continuous expansion and almost indefinite perpetuity which characterized the social organism separate this case widely from the biological, though their elements are necessarily homogeneous; and the separation will be the more indisputable, if we take into the account, as we are scientifically bound to do, the whole of the human race, instead of the portion whose history we have explored. In a logical view, we have seen that individual investigation would not yield us the method of filiation: and in a scientific view, it is equally clear that the knowledge of the laws of individual life can never enable us to make deductions of successive social phenomena; for each stage is deducible only from the one immediately preceding, though the aggregate must be in agreement with the system of biological ideas. While this separation is indispensable, it appears to constitute the chief difficulty, logical and scientific, of the most advanced minds, on account of the tendency of the earlier sciences to absorb the later, in virtue of their earlier positivity and their natural relations; tendencies so specious in this most recent case as to have ensnared almost every eminent thinker of our age. By the establishment of sociology we now witness the systematic fulfilment of the eternal conditions of the originality and pre-eminence of social speculations, which theology and metaphysics have instinctively struggled to maintain, though very insufficiently since the positive method began to prevail more and more in the modern mental evolution. In the name of positivism and rationality we have demanded and reconstructed the philosophical ascendency of social speculation, by undoing the work of the theological and metaphysical schools, which strove to isolate moral and political research from that system of natural philosophy with which we have now incorporated it. We see that the coalescing logical and scientific needs prescribe the subordination of this final science to all the rest, over which it then becomes preponderant by its philosophical reaction. This is the ground of my anxiety to point out the direct relations which result from the nature of the respective studies, on account of the constant necessity of the preparatory knowledge of the medium of the social evolution on the one hand, and the agent on the other. The place assigned to sociology in the encyclopedical scale is thus confirmed on all possible occasions, apart from the logical obligation to raise the positive method, by this successive procedure, to the sociological phase. But, whatever may be the importance of the ideas communicated by the inorganic sciences to sociology, the scientific office must especially belong to biology, which, from the nature of the subjects concerned, must always furnish the fundamental ideas that must guide sociological research; and often even rectify or improve the results. Moreover, it is biology which presents to us the domestic state, intermediate between individual and social existence, which is more or less common to all the superior animals, and which is, in our species, the true primitive basis of the more vast collective organism. However, the first elaboration of this new science could not but be essentially dynamical; so that the laws of harmony have nearly throughout been implicitly considered among the laws of succession, in which alone social physics can at present consist. The scientific link between biology and sociology is the connection of their two series, by which the second may be regarded as the prolongation of the first, though the terms of the one may be successive, and of the other, coexisting. With this difference, we find that the essential character of the human evolution results from the growing power of the superior attributes which place Man at the head of the animal hierarchy, where they also enable us to assign the chief degrees of animality. Thus we see the vast organic system really connecting the humblest vegetative existence with the noblest social life through a long succession, which, if necessarily discontinuous, is not the less essentially homogeneous. And, in as far as the principle of such a connection consists in the decreasing generality of the chief phenomena, this double organic series is connected with the rudimentary inorganic, the interior succession of which is determined by the same principle. The necessary direction of the human movement being thus ascertained, the only remaining task, in constituting sociology, was to mark out its general course. This was done by my ascertaining the law of evolution, which in connection with the hierarchical law, establishes a true philosophical system, the two chief elements of which are absolutely interconnected. In this dynamical conception, sociology is radically connected with biology, since the original state of humanity essentially coincides with that in which the superior animals are detained by their organic imperfection,—their speculative ability never transcending the primitive fetichism from which man could not have issued but for the strong impulsion of the collective development. The resemblance is yet stronger in the practical aspect. The sociological theory being thus constituted, nothing remained but to put it to the proof by an historical application of it to the intellectual and social progression of the most advanced portion of the human race through forty centuries. This test has discredited all the historical conceptions proposed before, and has shown the reality of the theory by explaining and estimating each phase as it passed in review, so as to enable us to do honor to the services of the most opposite influences,—as in the case of the polytheistic and monotheistic states. A political and philosophical preparation like this was necessary to emancipate the mind of the inquirer from the old philosophy and critical prejudices, and to substitute for them the scientific condition of mind which is indispensable for the humblest speculations, but far more necessary, and at the same time more difficult, in the case of the most transcendent and the most impassioned researches that the human mind can undertake. Thus the same conditions which required this task, at this time, are especially favorable to it. Its practical efficacy is inseparable from its theoretical soundness, because it connects the present, under all possible aspects, with the whole of the past, so as to exhibit at once the former course and the future tendency of every important phenomenon; and thence results, in a political view, the possibility of a natural connection between the science and the art of modern society. New as is this science, it has already fulfilled the essential conditions of its institution, so that it has only to pursue its special development. Its complexity is more than compensated by its interconnection, and the consequent preponderance of the collective spirit over the spirit of detail: and from its origin, therefore, it is superior in rationality to all the foregoing sciences, and is evidently destined to extend its own collective spirit over them by its reactive influence, thus gradually repairing the mischiefs of the dispersive tendencies proper to the preparatory stages of genuine knowledge.

Thus the scientific and the logical estimate are complete, and found to have attained the same point; and the long and difficult preparation proposed and begun by Descartes and Bacon is accomplished, and all made ready for the advent of the true modern philosophy. It only remains for me to show the action of this philosophy, intellectual and social, as far as it is at present rationally ascertainable, by means of a last and extreme application of our theory of human evolution.

CHAPTER XV.

ESTIMATE OF THE FINAL ACTION OF THE POSITIVE PHILOSOPHY.

No preceding revolutions could modify human existence to anything like the degree that will be experienced under the full establishment of the positive philosophy, which we have seen to be the only possible issue from the great crisis which has agitated Europe for half a century past. We have already perceived what must be the political task and character of this philosophy in a rapidly approaching time; and I have only therefore to point out, in a more general way, the natural action of the new philosophical system when it shall have assumed its throne. I will sketch the great impending philosophical regeneration from the four points of view which my readers will at once anticipate;—the scientific, or rather rational; the moral; the political; and finally, the æsthetic.

The scientific action.

The positive state will, in the first place, be one of entire intellectual consistency, such as has never yet existed in an equal degree, among the best-organized and most advanced minds. The kind of speculative unity which existed under the polytheistic system, when all human conceptions presented a uniformly religious aspect, was liable to perpetual disturbance from a spontaneous positivity of ideas on individual and familiar matters. In the scholastic period, the nearest approach to harmony was a precarious and incomplete equilibrium: and the present transition involves such contradiction that the highest minds are perpetually subject to three incompatible systems. It is impossible to conceive of the contrasting harmony which must arise from all conceptions being fully positive, without the slightest necessary intermixture of any heterogeneous philosophy. We may best form some idea of it by anticipating the total and final extension of the popular good sense, which, long confined to partial and practical operations, has at length taken possession of the speculative province. We are naturally familiar with the general wisdom which prevails in regard to the simplest affairs of life; and, when we shall habitually restrict our inquiries to accessible subjects, and understand, as of course, the relative character of all human knowledge, our approximation toward the truth, which can never be completely attained by human faculties, will be thorough and satisfactory as far as it goes; and it will proceed as far as the state of human progress will admit. This logical view will completely agree with the scientific conviction of an invariable natural order, independent of us and our action, in which our intervention can occasion none but secondary modifications; these modifications however being infinitely valuable, because they are the basis of human action. We have never experienced, and can therefore only imperfectly imagine, the state of unmingled conviction with which men will regard that natural order when all disturbing intrusions, such as we are now subject to from lingering theological influences, shall have been cast out by the spontaneous certainty of the invariableness of natural laws. Again, the absolute tendencies of the old philosophies prevent our forming any adequate conception of the privilege of intellectual liberty which is secured by positive philosophy. Our existing state is so unlike all this, that we can not yet estimate the importance and rapidity of the progress which will be thus secured; our only measure being the ground gained during the last three centuries, under an imperfect and even vicious system, which has occasioned the waste of the greater part of our intellectual labor. The best way of showing what advance may be made in sciences which are, as yet, scarcely out of the cradle, when systematically cultivated in an atmosphere of intellectual harmony, will be to consider the effect of positivity on abstract speculation first, then on concrete studies, and lastly on practical ideas.

Abstract speculation.

In abstract science, men will be spared the preliminary labor which has hitherto involved vast and various error, scientific and logical, and will be set forward far and firmly by the full establishment of the rational method. When the ascendency of the sociological spirit shall have driven out that of the scientific, there will be an end of the vain struggle to connect every order of phenomena with one set of laws, and the desired unity will be seen to consist in the agreement of various orders of laws,—each set governing and actuating its own province; and thus will the free expansion of each kind of knowledge be provided for, while all are analogous in their method of treatment, and identical in their destination. Then there will be an end to the efforts of the anterior sciences to absorb the more recent, and of the more recent to maintain their superiority by boasting of sanction from the old philosophies; and the positive spirit will decide the claims of each, without oppression or anarchy, and with the necessary assent of all. The same unquestionable order will be established in the interior of each science; and every proved conception will be secured from such attacks as all are now liable to from the irregular ambition or empiricism of unqualified minds. Though abstract science must hold the first place, as Bacon so plainly foresaw, the direct construction of concrete science is one of the chief offices of the new philosophical spirit, exercised under historical guidance, which can alone afford the necessary knowledge of the successive states of everything that exists. Besides the light which will thus be cast on the elementary laws of all kinds of action, and the valuable practical suggestions which must be thus obtained, there will be another result which I ought to point out, which could not be otherwise obtained, and which relates especially to the highest and most complex phenomena. I mean the fixing,—not yet possible, but then certainly practicable,—of the general duration assigned by the whole economy to each of the chief kinds of existence; and, among others, to the rising condition of the human race. This great evolution, which has scarcely yet escaped from its preparatory stage, must certainly continue to be progressive through a long course of centuries, beyond which it would be equally inopportune and irrational to speculate; yet it is of consequence to the development of the philosophical spirit to admit in principle that the collective organism is necessarily subject, like the individual, to a spontaneous decline, independently of changes in the medium. The one has no more tendency to rejuvenescence than the other; and the only difference in the two cases is in the immensity of duration and slow progression in the one, compared with the brief existence, so rapidly run through, of the other. There is no reason why, because we decline the metaphysical notion of indefinite perfectibility, we should be discouraged in our efforts to ameliorate the social state; as the health of individuals is ministered to when destruction is certainly near at hand. Nor need we attempt to determine the last aspects that the philosophical spirit will assume, in an extremely remote future, always ready as that spirit is to recognise, without any fruitless disturbance, any destiny which is clearly inevitable, in order to solace

Concrete research.

the natural pain of decline by nobly sustaining the dignity of humanity. It is too soon in infancy to prepare for old age; and there would be less wisdom in such preparation in the collective than in the individual case. As to the case of practical knowledge,—the most obvious prospect is of the permanent agreement that will be established between the practical point of view and the speculative, when both are alike subordinated to the philosophical. The practical development must go on rapidly under the ascendency of rational positivity; and, on the other hand, technical advancement will be equally efficacious in proving the immense superiority of the true scientific system to the desultory state of speculation that existed before. The sense of action and that of prevision are closely connected, through their common dependence on the principle of natural law; and this connection must tend to popularize and consolidate the new philosophy, in which each one will perceive the realization of the same general course with regard to all subjects accessible to our reason. The medical art, and the political, will be instances, when they shall rise out of their present infantile state, and be rationalized under the influence of a true philosophical unity, and concrete studies shall, at the same time, have been properly instituted. As the most complex phenomena are the most susceptible of modification, the true relation between speculation and action will be most conspicuous in the provinces which are most nearly concerned with the human condition and progress. Such will be the results in the intellectual portion of future human life.

The moral action.

As to the moral,—its antagonism with the intellectual will be proved to be what we have shown it—merely provisional; and dissolved at once when the sociological point of view is established as the only true one. I need not dwell on so clear a point as the moral tendency of the scientific elevation of the social point of view, and of the logical supremacy of collective conceptions, such as characterize the positive philosophy. In our present state of anarchy, we see nothing that can give us an idea of the energy and tenacity that moral rules must acquire when they rest on a clear understanding of the influence that the actions and the tendencies of every one of us must exercise on human life. There will be an end then of the subterfuges by which even sincere believers have been able to elude moral prescriptions, since religious doctrines have lost their social efficacy. The sentiment of fundamental order will then retain its steadiness in the midst of the fiercest disturbance. The intellectual unity of that time will not only determine practical moral convictions in individual minds, but will also generate powerful public prepossession, by disclosing a plenitude of assent, such as has never existed in the same degree, and will supply the insufficiency of private efforts, in cases of very imperfect culture, or entanglement of passion. The instrumentality will not be merely the influence of moral doctrine, which would seldom avail to restrain vicious inclinations; there would be first the action of a universal education, and then the steady intervention of a wise discipline, public and private, carried on by the same moral power which had superintended the earlier training. The results can not be even imagined without the guidance of the doctrines themselves, under their natural division into personal, domestic, and social morality.

Personal morality.

Morality must become more practical than it ever could be under religious influences, because personal morality will be seen in its true relations,—withdrawn from all influences of personal prudence, and recognised as the basis of all morality whatever, and therefore as a matter of general concern and public rule. The ancients had some sense of this, which they could not carry out; and Catholicism lost it by introducing a selfish and imaginary aim. We should fix our attention on the advantages that must arise from the concentration of human efforts on an actual life, individual and collective, which Man is impelled to ameliorate as much as possible in its whole economy, according to the whole of the means within his power,—among which, moral rules certainly hold the very first place, because they especially admit of the universal concurrence in which our chief power resides. If we are thus brought back from an immoderate regard to the future by a sense of the value of the present, this will equalize life by discouraging excessive economical preparation; while a sound appreciation of our nature, in which vicious or unregulated propensities originally abound, will render common and unanimous the obligation to discipline, and regulate our various inclinations. Again, the scientific and moral conception of Man as the chief of the economy of nature will be a steady stimulus to the cultivation of the noble qualities, affective as well as intellectual, which place him at the head of the living hierarchy. There can be no danger of apathy in a position like this,—with the genuine and just pride of such pre-eminence stirring within us; and above us the type of perfection, below which we must remain, but which will ever be inviting us upward. The result will be a noble boldness in developing the greatness of Man in all directions, free from the oppression of any fear, and limited only by the conditions of life itself. As for domestic morality, we have seen what is the subordination prescribed by nature in the cases of sex and of age. It is here, where sociology and biology meet, that we find how profoundly natural social relations are, as they are immediately connected with the mode of existence of all the higher animals, of which Man is only the more complete development: and an application of the uniform positive principle of classification, abstract and concrete, will consolidate this elementary subordination, by connecting it with the whole of the speculative constitution. It will moreover be found that progression will develop more and more the natural differences on which such an economy is based, so that each element will tend toward the mode of existence most suitable to itself, and consonant with the general welfare. While the positive spirit will consolidate

Domestic.

the great moral ideas which belong to this first stage of association, it will exhibit the increasing importance of domestic life for the vast majority of men, as modern sociality approaches its truest condition ; and the natural order, by which domestic life becomes the proper introduction to social, will be established, past risk of change

Social.

The positive philosophy is the first that has ascertained the true point of view of social morality. The metaphysical philosophy sanctioned egotism ; and the theological subordinated real life to an imaginary one ; while the new philosophy takes social morality for the basis of its whole system. The two former systems were so little favorable to the rise of the purely disinterested affections, that they often led to a dogmatic denial of their existence ; the one being addicted to scholastic subtilties, and the other to considerations of personal safety. No set of feelings can be fully developed otherwise than by special and permanent exercise ; and especially if they are not naturally very prominent ; and the moral sense,—the social degree of which is its completest manifestation,—could be only imperfectly instituted by the indirect and factitious culture of a preparatory stage. We have yet to witness the moral superiority of a philosophy which connects each of us with the whole of human existence, in all times and places. The restriction of our expectations to actual life must furnish new means of connecting our individual development with the universal progression, the growing regard to which will afford the only possible, and the utmost possible, satisfaction to our natural aspiration after eternity. For instance, the scrupulous respect for human life, which has always increased with our social progression, must strengthen more and more as the chimerical hope dies out which disparages the present life as merely accessory to the one in prospect. The philosophical spirit being only an extension of good sense, it is certain that it alone, in its spontaneous form, has for three centuries maintained any general agreement against the dogmatic disturbances occasioned or tolerated by the ancient philosophy, which would have overthrown the whole modern economy if popular wisdom had not restrained the social application of it. The effects are, at best, only too evident : the practical intervention of the old philosophy taking place only in cases of very marked disorder, such as must be always impending and ever renewed while the intellectual anarchy which generates it yet exists. By its various aptitudes, positive morality will tend more and more to exhibit the happiness of the individual as depending on the complete expansion of benevolent acts and sympathetic emotions toward the whole of our race ; and even beyond our race, by a gradual extension to all sentient beings below us, in proportion to their animal rank and their social utility. The relative nature of the new philosophy will render it applicable, with equal facility and accuracy, to the exigencies of each case, individual or social, whereas we see how the absolute character of religious morality has deprived it of almost all force in cases which, arising after its institution, could not have been duly provided for. Till the full rational establishment of positive morality has taken place, it is the business of true philosophers, ever the precursors of their race, to confirm it in the estimation of the world by the sustained superiority of their own conduct, personal, domestic, and social; giving the strongest conceivable evidence of the possibility of developing, on human grounds alone, a sense of general morality complete enough to inspire an invincible repugnance to moral offence, and an irresistible impulse to steady practical devotedness.

Political action.

The political results of the positive philosophy have been so mixed up with the whole treatment of the future in this book, and the near future has been so expressly exhibited in the twelfth chapter, that I need say little here under that head. I have only to glance at the growth and application of the division between the spiritual or theoretical organism and the temporal or practical, the beginning of which I have already sufficiently described.

Double government.

We have seen that Catholicism afforded the suggestion of a double government of this kind, and that the Catholic institution of it shared the discredit of the philosophy to which it was attached: and again, that the Greek Utopia of a Reign of Mind (well called by Mr. Mill a Pedantocracy), transmitted to the modern metaphysical philosophy, gained ground till its disturbing influence rendered it a fit subject for our judgment and sentence. The present state of things is that we have a deep and indestructible, though vague and imperfect, sense of the political requirements of existing civilization, which assigns a distinct province, in all affairs, to the material and the intellectual authority, the separation and co-ordination of which are reserved for the future. The Catholic division was instituted on the ground of a mystical opposition between heavenly and earthly interests, as is shown by the terms spiritual and temporal, and not at all from any sound intellectual and social appreciation, which was not then possible, nor is possible even yet; and when the terrestrial view prevailed over the celestial, the principle of separation was seriously endangered, from there being no longer any logical basis which could sustain it against the extravagances of the revolutionary spirit. The positive polity must therefore go back to the earliest period of the division, and re-establish it on evidence afforded by the whole human evolution; and, in its admission of the scientific and logical preponderance of the social point of view, it will not reject it in the case of morality, which must always allow its chief application, and in which everything must be referred, not to Man, but to Humanity. Moral laws, like the intellectual, are much more appreciable in the collective than in the individual case; and, though the individual nature is the type of the general, all human advancement is much more completely characterized in the general than in the individual case; and thus morality will always, on both grounds, be connected with polity. Their separation will arise from that distinction between theory and practice which is indispensable to the common destination of both. We may already sum up the ultimate conditions of positive polity by conceiving of its systematic wisdom as reconciling the opposing qualities of that spontaneous human wisdom successively manifested in antiquity and in the Middle Ages; for there was a social tendency involved in the ancient subordination of morality to policy, however carried to an extreme under polytheism; and the monotheistic system had the merit of asserting, though not very successfully, the legitimate independence, or rather, the superior dignity of morality. Antiquity alone offered a complete and homogeneous political system; and the Middle Ages exhibit an attempt to reconcile the opposite qualities of two heterogeneous systems, the one of which claimed supreme authority for theory, and the other for practice. Such a reconciliation will take place hereafter, on the ground of the systematic distinction between the claims of education and of action. We find something like an example of how this may be done,—theory originating practice, but never interfering with it except in a consultative way,—in the existing relations between art and science, the extension of which to the most important affairs, under the guidance of sound philosophy, contemplating the whole range of human relations. If the whole experience of modern progress has sanctioned the independence, amidst co-operation, of theory and practice, in the simplest cases, we must admit its imperative necessity, on analogous grounds, in the most complex. Thus far, in complex affairs, practical wisdom has shown itself far superior to theoretical; but this is because much of the proudest theory has been ill-established. However this evil may be diminished when social speculation becomes better founded, the general interest will always require the common preponderance of the practical or material authority, as long as it keeps within its proper limits, admitting the independence of the theoretical authority; and the necessity of including abstract indications among the elements of every concrete conclusion. No true statesman would think of disputing this, when once the philosophers had evinced the scientific character and the political aspect adapted to their social destination. It may be well however to present, in a summary way, the rational securities which will exist against any encroachment of moral upon political government, in order to meet the instinctive prejudices which still oppose the advent of what I have shown to be the first social condition of final regeneration.

In treating of the training for such an organization, I insisted on limiting it to the five nations of Western Europe, in order to secure its distinctness and originality from the confusion of modern speculative habits. But such a restriction must give way when we contemplate the final extension of the positive organism, first to the whole of the white race, and at length to the whole of mankind, as their preparation becomes complete. It was the theological philosophy which divided Western Europe into independent nationalities for five centuries past; and their interconnection, determined by their positive progression, can be systemized only by the process of total renovation. The European case must be much fitter than the national for manifesting the qualities of the spiritual constitution; and it will acquire new consistence and efficacy after each new extension of the positive organism, which will thus become more and more moral, and less and less political; the practical authority all the while preserving its active preponderance. By a necessary reaction, liberty will gain as much as order by this inevitable progression; for as intellectual and moral association becomes confirmed by extension the temporal authority which is now necessary to keep the social system together will naturally relax as repression becomes less and less needed. As for the influence of human passions, which will arise under the new system as under every other, I have already spoken of them, so as to need only to say here that they will affect the early institution of the system more than its normal development. We have still to reap some of the bitter fruits of our intellectual and moral anarchy: and especially, in the quarrels between capitalists and laborers first, and afterward in the unsettled rivalship between town and country. In short, whatever is now systemized must be destroyed; and whatever is not systemized, and therefore has vitality, must occasion collisions which we are not yet able accurately to foresee or adequately to restrain. This will be the test of the positive philosophy, and at the same time the stimulus to its social ascendency. With this troubled initiation, the worst will be over. The difficulties proper to the action of the new *régime*, the same in kind, will be far less in degree, and will disappear as the conditions of order and progress become more and more thoroughly reconciled. We have seen that the advent of the positive economy will have been owing to the affinity between philosophical tendencies and popular impulses: and if so, it is easy to see how that affinity must become the most powerful permanent support of the system. The same philosophy which asserts the intellectual supremacy of the general reason can not but admit, without any danger of anarchy, the social supremacy of genuine popular needs, by establishing the universal sway of morality, governing at once scientific energies and political conclusions. And thus, after some passing troubles, occasioned by the unequal development of practical exigencies and theoretical satisfactions, the positive philosophy, in its political form, will necessarily lead up the human race to the social system which is most suitable to the nature of Man, and which will greatly surpass in unity, extension, and stability, all that the past has ever produced.

The æsthetic action

One of the least anticipated results of this working out of opinions, morals, and institutions under the guidance of positive philosophy, is the development which must take place in the modes of expressing them. For five centuries, society has been seeking an æsthetic constitution correspondent to its civilization. In the time to come,—apart from all consideration of the genius that will arise which is wholly out of the reach of anticipation,—

we may see how Art must eminently fulfil its chief service, of charming and improving the humblest and the loftiest minds, elevating the one, and soothing the other. For this service it must gain much by being fitly incorporated with the social economy, from which it has hitherto been essentially excluded. Our philosophical speculation has shown us how favorable the human view and collective spirit must be to the rise and spread of æsthetic tastes; and our historical survey had before taught us, that a progressive social condition, marked and durable, is indispensable to the completeness of such a development. On both grounds, the future is full of promise. The public life and military existence of antiquity are exhausted; but the laborious and pacific activity proper to modern civilization is scarcely yet instituted, and has never yet been æsthetically regarded; so that modern art, like modern science and industry, is so far from being worn out, that it is as yet only half formed. The most original and popular species of modern art, which forms a preparation for that which is to ensue, has treated of private life, for want of material in public life. But public life will be such as will admit of idealization: for the sense of the good and the true can not be actively conspicuous without eliciting a sense of the beautiful; and the action of the positive philosophy is in the highest degree favorable to all the three. The systematic regeneration of human conceptions must also furnish new philosophical means of æsthetic expansion, secure at once of a noble aim and a steady impulsion. There must certainly be an inexhaustible resource of poetic greatness in the positive conception of Man as the supreme head of the economy of Nature, which he modifies at will, in a spirit of boldness and freedom, within no other limits than those of natural law. This is yet an untouched wealth of idealization, as the action of Man upon Nature was hardly recognised as a subject of thought till art was declining from the exhaustion of the old philosophy. The marvellous wisdom of Nature has been sung, in imitation of the ancients, and with great occasional exaggeration; and the conquests of Man over nature, with science for his instrument, and sociality for his atmosphere, remains, promising much more interest and beauty than the representation of an economy in which he has no share, and in which magnitude was the original object of admiration, and material grandeur continues to be most dwelt upon. There is no anticipating what the popular enthusiasm will be when the representations of Art shall be in harmony with the noble instinct of human superiority, and with the collective rational convictions of the human mind. To the philosophical eye it is plain that the universal reorganization will assign to modern Art at once inexhaustible material in the spectacle of human power and achievement, and a noble social destination in illustrating and endearing the final economy of human life. What philosophy elaborates, Art will propagate and adapt for propagation, and will thus fulfil a higher social office than in its most glorious days of old.—I have here spoken of the first of the arts only,—of Poetry, which by its superior amplitude and generality has always superintended and led the development of them all: but the conditions which are favorable to one mode of expression are propitious to all, in their natural succession. While the positive spirit remained in its first phase, the mathematical, it was reproached for its anti-æsthetic tendency: but we now see how, when it is systemized from a sociological centre, it becomes the basis of an æsthetic organization no less indispensable than the intellectual and social renovation from which it is inseparable.

The Five Nations. The five elements of this great process will each bring their own special contribution to the new system, which will inseparably combine them all. France will bring a philosophical and political superiority; England, an earnest predilection for reality and utility; Germany a natural aptitude for systematic generalization; Italy, its genius for art; and Spain, its familiar combined sense of personal dignity and universal brotherhood. By their natural co-operation, the positive philosophy will lead us on to a social condition the most conformable to human nature, in which our characteristic qualities will find their most perfect respective confirmation, their completest mutual harmony, and the freest expansion for each and all.

THE END.

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